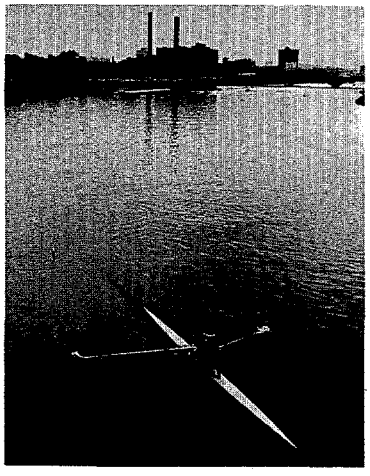
Report of the Southeastern New England Study



a Strategy for Balanced Development and Protection of Water and Related Land Resources in Eastern Massachusetts and Rhode Island

7. BLACKSTONE AND VICINITY PLANNING AREA REPORT

New England River Basins Commission

The Southeastern New England Study (SENE) is a "level B water and related land resources study." It was conducted under the provisions of the federal Water Resources Planning Act of 1965. The resources management program the Study produced was developed by a team of federal, state, and regional officials, local citizens, and the scientific community, under the overall coordination of the New England River Basins Commission. It is a part of the Commission's comprehensive, coordinated joint plan for the water and related land resources of New England.

The recommended program for managing the resources of Southeastern New England is described, in increasing level of detail, in the following Final Reports:

A SUMMARY highlighting the principal findings and recommendations of the Study, and their implications for the future of the region.

A REGIONAL REPORT and Environmental Impact Statement describing *in detail* the natural resources, issues and problems facing the region, the alternative solutions examined during the Study, the recommendations made, and their implications. It includes policies and programs for dealing with water supply, land use, water quality, outdoor recreation, marine resources, flood and erosion protection, and key facilities siting, and the changes in state and local government required to implement the program.

Ten PLANNING AREA REPORTS dealing with the same subjects as the Regional Report, but aimed at the local level. Eastern Massachusetts and Rhode Island were divided into ten "planning areas" based either on traditional sub-state divisions or principal river basins. Reports were prepared for the following areas:

1. **Ipswich-North Shore,**
2. **Boston Metropolitan,**
3. **South Shore,**
4. **Cape Cod and the Islands,**
5. **Buzzards Bay,**
6. **Taunton,**
7. **Blackstone and Vicinity,**
8. **Pawtuxet,**
9. **Narragansett Bay and Block Island,**
10. **Pawcatuck**

Other reports prepared during the course of the Study include the following:

Inventory Reports

For each of the ten planning areas, inventory reports were prepared covering the following subjects: climate, meteorology, hydrology, geology; land use, patterns, allocations, and management; special environmental factors; water supply; ground water management; water quality control; outdoor recreation; fish and wildlife; navigation; flood plain zoning and streamflow management; inland wetlands management; coastal resources; irrigation and drainage; sediment and erosion; power; minerals.

Special Reports

In addition to inventory reports, over a dozen special reports were prepared, including: Socio-Economic and Environmental Base Study, Volumes I and II; Economic analyses of water supply and demand issues, power plant siting, coastal resources allocation, and sand and gravel mining; Legal and institutional analyses of the state wetlands laws, arrangements for water supply service, fiscal policy and land control, access to natural resources areas, and management structure for water and land use issues; Urban Waters Special Study; Summaries of public workshops

Copies of reports are available from:

New England River Basins Commission
55 Court Street
Boston, Massachusetts 02108

National Technical Information
Service
Springfield, Virginia 22151

and also in each of the 208 libraries and 210 town halls throughout the SENE region.

Report of the Southeastern New England Study

a Strategy for Balanced Development and Protection of Water and Related Land Resources in Eastern Massachusetts and Rhode Island

7. BLACKSTONE AND VICINITY PLANNING AREA REPORT

New England River Basins Commission
December, 1975

SUMMARY, REGIONAL REPORT
(with Environmental Statement), and
10 PLANNING AREA REPORTS

REPORT OF THE SOUTHEASTERN NEW ENGLAND STUDY

READER'S GUIDE: HOW TO REVIEW THIS REPORT

- In five minutes

  FOR A "THUMBNAIL SKETCH"

  Read the **OVERVIEW** which folds out as one large sheet. There is an extra copy in the pocket in the rear for those who would like to mount it on the wall.

- In a half hour or less

  TO LEARN THE MAIN POINTS

  Read the **SUMMARY**. It is published separately. You can read it in either of two ways:

  - **SELECTIVELY.** Read the Chapters on Goals and Approach and Guiding Growth, plus any others that interest you. Chapters are boldly labeled to facilitate selective reading; or

  - **ENTIRELY.** Read the full summary for a fuller understanding of the highlights of the SENE Study.

- In one day or less

  TO UNDERSTAND THE DETAILS

  Read the **REGIONAL REPORT.**

  - **SELECTIVELY.** It is organized exactly like the summary. Wherever your interests lie, you can turn to those sections for additional background, amplifications, analysis of rejected alternatives, and especially for the full text of each recommendation, including who should do what and when. Also, remove the Development Capabilities Maps in the rear pocket and examine the legend to appreciate the type of information the maps portray; or

  - **ENTIRELY.** Read the full report for full appreciation of all recommendations, and how they interrelate.

- In an additional 10 minutes to 2 hours

  FOR APPLICATION TO YOUR AREA

  Get the **PLANNING AREA REPORT** for your locale. Scan it or read it to see how the broader recommendations presented in the Regional Report may apply to the area where you live or work.

TABLE OF CONTENTS

7. Blackstone and Vicinity Planning Area Report

OVERVIEW

Blackstone and Vicinity Planning Area

What is the point of the SENE Study program?

Balanced use and conservation of the region's water and related land resources is the program's objective. The Southeastern New England (SENE) Water and Related Land Resources Study was authorized and funded by Congress in response to the increasingly troublesome pressures the region's rapid urbanization was exerting on its rich and varied natural resources. The SENE Study has two major goals:

- To recommend actions for all levels of government and private interests to secure for the people of the region the full range of uses and benefits which may be provided by balanced use and conservation of the region's water and related lands.

- To assemble information on the resources at a consistent scale and level of detail.

What makes this Study different is that it covers a relatively large geographic area (4400 square miles), it addresses a full range of water and related land issues, and it proposes coordinated actions for all levels of government and private interests.

What does the SENE Program cover?

The most important recommendations for this planning area include the following:

(1) To accommodate growth in environmentally and economically acceptable ways, municipalities should prohibit or restrict development on Critical Environmental Areas such as wetlands, flood plains, and well sites. Growth should be guided to Developable Areas which cover 34 percent of the planning area. Within this category, municipalities should manage development on resources such as steep slopes, ledge, and soils with septic limitations. Development should be encouraged where services already exist or are planned.

(2) To provide a sufficient supply of water, expand existing surface and ground water sources, including acquiring the Tarkiln and Nipmuc Reservoir sites by 1990. Consolidate water supply systems in Burrillville and Smithfield, and seek an agreement with the Taunton regional system to meet Attleboro's future needs and the emergency needs of North Attleborough. Approve the Big River Reservoir project, thereby expanding the Providence system which serves a number of planning area municipalities.

(3) To maintain and improve water quality, construct, expand, and upgrade municipal treatment plants throughout the planning area. Complete separation of combined sewers in Worcester, and provide partial separation in Central Falls, Pawtucket, and Providence.

(4) To expand opportunities for outdoor recreation, expand existing areas and acquire new ones, including increased public access to lakes, streams, and ponds. Special emphasis should be given to increasing recreational opportunities in, or near, urban areas. Permit low-intensity outdoor recreation on storage reservoir lands. Create a Ten Mile River recreation complex and a Blackstone River Park, and consider a trail system from Douglas to Providence.

(5) To reduce flood damages, regulate new flood plain development. Direct flood plain management programs to non-structural solutions wherever possible, recognizing that flooding and erosion are natural processes that cannot be fully controlled. Carry out structural measures only where non-structural means are unavailable or inadequate.

What will the program do?

If the recommended actions are carried out, most 1990 needs for water, sewers, electric power, and outdoor recreation could be met by making more efficient use of existing facilities, legal authorities, and institutional designs. Protecting Critical Environmental Areas will avoid potential dangers to life and property from flooding, erosion, and contamination of water quality; and will provide productive greenbelts. As a result, new growth in this planning area in the SENE region can be accommodated without harming the high quality environment which attracted the growth in the first place.

You can take the first step in helping to carry out the program by reading the recommendations in the SENE Study's Regional and Planning Area Reports. Write your state and Congressional representatives about the Study. Urge your local planning and conservation officials to use the SENE Study planning process when developing or implementing master plans, zoning ordinances such as flood plain and watershed protection, and other water and land use decisions.

RECOMMENDATIONS

GUIDING GROWTH (Chapter 3)

1. Protect priority Critical Environmental Areas.
2. Restrict development on other Critical Environmental Areas.
3. Manage growth on Developable Areas.
4. Incorporate SENE Study findings into the Rhode Island land use plan.
5. Use SENE resource development capability analysis to guide future growth in Massachusetts.
6. Accommodate growth where services already exist.

WATER SUPPLY (Chapter 4)

1. Survey ground water location, quantity, and availability in Upper Blackstone basin.
2. Meter all water use in the Upper Blackstone for planning system management.
3. Investigate advantages of closer water system cooperation in Upper Blackstone.
4. Increase activities in field of water supply, public information, and education in the Upper Blackstone.
5. Expand Worcester's existing surface water systems.
6. Establish connections to Worcester system in Auburn, Millbury, Grafton, Shrewsbury, and Upton.
7. Explore and develop ground water sources in the Upper Blackstone municipalities.
8. Pursue local surface water development only where necessary in the Upper Blackstone.
9. Develop interconnection with Uxbridge to serve Millville.
10. Investigate development of Hopedale Pond as a water supply source.
11. Acquire Tarkiln and Nipmuc Reservoir sites by 1990.
12. Plan for protection of reservoirs serving Pawtucket, Cumberland, and Woonsocket.
13. Construct iron and manganese removal facilities for Cumberland's sources.
14. Make plans to treat and use Harris Pond to augment Woonsocket's existing supplies.
15. Explore and develop additional ground water in North Smithfield.
16. Consolidate the existing water systems serving Burrillville.
17. Develop additional ground water to serve Chepachet section of Glocester.
18. Develop additional ground water in Plainville, Seekonk, and North Attleborough.
19. Supplement Attleboro supplies through the Taunton regional system.
20. Establish an emergency connection between North Attleborough and Taunton.
21. Consolidate three systems currently serving Smithfield.
22. Petition the General Assembly to approve construction of the Big River Reservoir.
23. Expand and treat ground water supplies in Lincoln.

WATER QUALITY (Chapter 5)

1. Carry out current state non-degradation policies.
2. Emphasize treatment of combined sewer overflows.
3. Begin stormwater and wet-weather stream sampling.
4. Continue current industrial permits program.
5. Construct advanced treatment plant for Upper Blackstone towns.
6. Complete separation of combined sewers in Worcester by 1980.
7. Upgrade treatment plant to advanced to serve Millbury and Sutton.
8. Construct advanced treatment plant in Grafton.
9. Maintain advanced treatment plant in Northbridge.
10. Provide advanced treatment in Upton after 1985.
11. Provide advanced treatment in Hopedale by 1978.
12. Construct advanced treatment plant in Uxbridge by 1978.
13. Construct secondary treatment plant in Douglas.
14. Connect Blackstone to Woonsocket's treatment plant by 1976.
15. Provide secondary treatment in Woonsocket and other towns by mid-1977.
16. Construct secondary treatment plant in Burrillville by mid-1977.
17. Maintain secondary treatment plant for Blackstone Valley Sewer District.
18. Provide partial separation of combined sewer overflows in Central Falls and Pawtucket.
19. Expand and upgrade North Attleborough plant to advanced by 1977.
20. Expand and upgrade Attleboro plant to advanced by 1979.
21. Provide secondary treatment to Barrington from East Providence plant.
22. Construct advanced treatment plant in Smithfield.
23. Expand sewer service in Lincoln.
24. Continue service from Providence treatment facility to five municipalities.
25. Study and define the landfill leachate problem.

OUTDOOR RECREATION (Chapter 6)

General Outdoor Recreation

1. Develop guidelines to plan for low-intensity recreation on storage reservoir lands.
2. Acquire local access near 4 Rhode Island lakes.
3. Acquire statewide access along Crystal Pond in Douglas.
4. Acquire inner-city recreation opportunities in at least 6 municipalities.
5. Consider a trail system from Douglas to Providence.
6. Enlarge Douglas State Forest, consolidate Upton State Forest, and provide support for the towns.
7. Expand Diamond Hill, Lincoln Woods, and Casimir Pulaski State Parks.
8. Create a Ten Mile River recreation complex.
9. Create a Blackstone River Park.
10. Use SENE Development Capabilities Maps for open space protection.

Fish and Wildlife

11. Use the Massachusetts Natural Resources Planning Program to enforce wetlands legislation.
12. Provide technical assistance to Rhode Island municipalities to enforce wetlands legislation.
13. Acquire the most significant wildlife habitats.
14. Include ponds 10 acres and larger for fishing in Massachusetts Great Ponds legislation.
15. Acquire access to ponds with good potential for fisheries production.
16. Acquire access to streams with good potential for fisheries production.

MARINE MANAGEMENT (Chapter 7)

1. Coordinate local waterfront planning and development.
2. Provide guidance and set criteria at the state level for priority waterfront uses.
3. Review and coordinate waterfront use.
4. Provide federal funding support for state and local waterfront development plans.

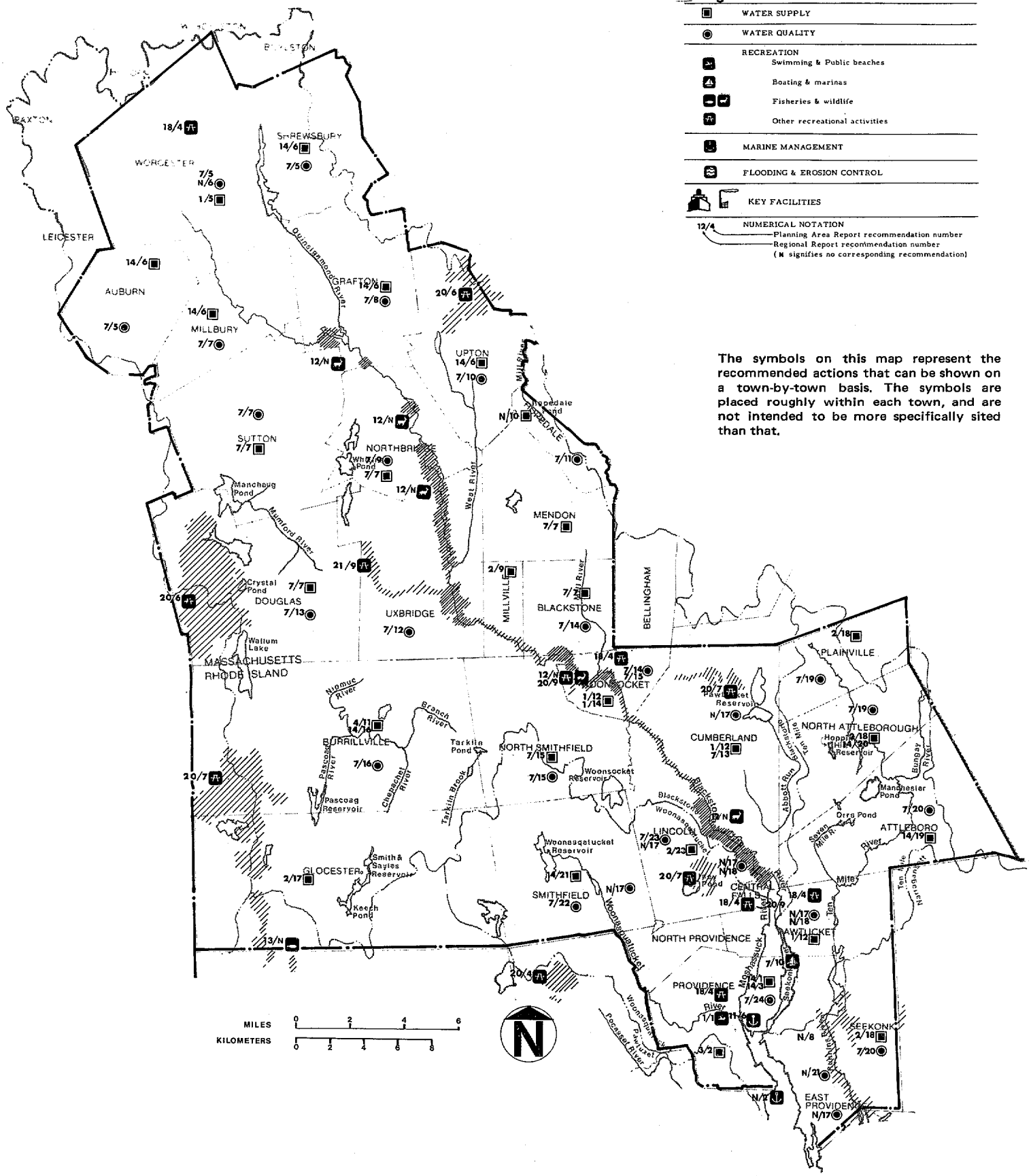
(See also Narragansett Bay Planning Area Report.)

FLOODING AND EROSION (Chapter 8)

1. Develop comprehensive flood plain management programs giving priority to non-structural measures.
2. Apply structural solutions selectively.
3. Adopt local flood plain zoning preventing adverse flood plain development.
4. Establish local sediment and erosion control ordinances.
5. Establish forest buffer zones.
6. Establish a forestry program.
7. Establish local regulations to strengthen flood plain management.
8. Acquire key flood plains and wetlands.
9. Locate in existing safe buildings in the flood plain.

LOCATING KEY FACILITIES (Chapter 9)

See Regional Report – Chapter 9



NEW ENGLAND RIVER BASINS COMMISSION
BOSTON, MASSACHUSETTS

SOUTHEASTERN NEW ENGLAND
WATER AND RELATED LAND RESOURCES STUDY

Blackstone and Vicinity Planning Area
Recommended Actions

CHAPTER 1 THEMES

This report on the Blackstone and Vicinity planning area is one component of a comprehensive program for managing water and related land resources in the Southeastern New England (SENE) region. The Study's Regional Report has presented recommended policies and actions from a region-wide or statewide perspective. This Planning Area Report includes applications of those broad-based recommendations to the cities and towns in the Blackstone River area and vicinity.

One reason for preparing the planning area reports is to connect the actions at the local level with the policy framework and considerations for state and federal levels. This direction was chosen as a response to the region's long history of local autonomy and to the Study's emphasis on placing decision making at the lowest level commensurate with the anticipated scope of the decision. The planning area boundaries follow the town lines most closely approximating the hydrologic boundaries of river basins.

Three common themes link all the reports:

- **Enhancing the environment enhances the economy.** Preventing degradation of the area's remaining natural resources can both decrease the cost of development of the taxpayer and protect the amenities which are the region's competitive economic advantage.

- **Anticipated growth can be accommodated, but it needs guidance.** There is enough land to accept new growth and still protect Critical Environmental Areas. But that growth should be guided to lands which can support development, and within those lands, to areas already served by essential water, sewer, and transportation services.

- **Existing knowledge, programs, and institutions provide the most realistic tools for achieving results, but some changes are needed.** Full use of ongoing programs, with some changes in how they relate to each other, was viewed as a way of "piggy-backing" on programs which have already weathered most of the realities of the political process. In choosing this strategy, the Study traded off novelty to increase achievability.

Each major chapter in this report contains actions to solve water and related land problems which we face now, or can expect to face in the next 15 years, and in some cases into the next century. Table 1.1 sets out the intensity of these problems within each planning area, between them, and for the region as a whole.

Four of the resource subjects were judged "severe" problems:

- **Guiding Growth.** Extensive areas have urbanized, and the planning area has, relative to the region, a small share of Critical Environmental Areas.

- **Water Supply.** A need for additional water supplies in the area within the next 15 to 25 years will make development of new ground and surface water sources necessary.

- **Water Quality.** Combined sewers and urban stormwater runoff, industrial discharges, and municipal discharges combine to make serious pollution an important issue for both Massachusetts and Rhode Island.

- **Flooding.** Extensive flood plain development, particularly in the lower portions of the planning area, plus hilly topography in the upper reaches of the Blackstone basin, contribute to the most serious flood damages in the SENE region.

Recreation was judged a major problem because of shortages of swimming, boating, and camping and picnicking opportunities, and particularly of hunting and fishing access.

TABLE 1.1 GENERAL INTENSITY OF SENE WATER - RELATED PROBLEMS BY PLANNING AREA

Key

- ● Severe problem
- ○ Major problem
- • Moderate problem
- Blank Minor or no problem

										Land Use Discharge																											
	GUIDING GROWTH (Overall)	Protection of Critical Environmental Areas	Management of Developable Areas	**WATER SUPPLY**	**WATER QUALITY (Overall)**	Combined Sewers/Urban-Runoff	Municipal Discharges	Industrial Discharges	Low Streamflow	Septic Systems	Agricultural Runoff	Landfill Leachate	Oil Pollution	Watercraft Wastes	**RECREATION (Overall)**	Swimming	Boating	Recreational Saltwater Fishing	Camping and Picnicking	Access to Hunting and Fishing Opportunities	Passive Outdoor Recreation	**MARINE MANAGEMENT (Overall)**	Offshore Fisheries	Shellfish and Aquaculture	Port Development	Offshore Sand and Gravel	Urban Waterfronts	**FLOODING AND EROSION (Overall)**	Inland Flooding	Coastal Flooding	Inland Erosion	Coastal Erosion	**LOCATING KEY FACILITIES (Overall)**	Availability of Sand and Gravel	Power Plant Siting	Petroleum Facilities Siting	Solid Waste Management
PLANNING AREAS																																					
Ipswich - North Shore	●	○	●	○	○	•	○	•	○	●		○	•	•	•	○	●	•	●	○	○	•	●	○			•	○	•	○		•	○	○	●	•	
Boston Metropolitan	●	○	○	●	●	●	●	●	•			○	○	•	●	●	●	○	○	●	●	○	○		●	○	●	•	○	•		•	○	○		●	
South Shore	○	•	○	•	○		○	•	○	○	•			•		●	○			○	•			•				○		○		•	○	○	○		
Cape Cod and the Islands	○	●	•	○	•		○			●	•	•		○	•		•		○	•				•						•		•		○			
Buzzards Bay	•	●			○	●	○	○		•	○			•	○		•			•		•	●	•			•			•					○		
Taunton	○	●	•	○	●	○	●	●	○	○	○		•		•	●			○	•	•						•	•		•			•				
Blackstone and Vicinity	●	•		●	●	●	●	●	•	•		○	○		○	○	○		○	●	○	•			○	○	●	●	●	•			•				
Pawtuxet	○	•	•		●		●	●	●	•					•	●		•		○								○	●					○			
Narragansett Bay	○	●	●	○	○	●	○	•					○	○	•	○	○	○		○	○	○	●	•	●		•	○		○		•	○		○	●	
Pawcatuck	•	○			•		○	○		○				•			•			•				•				•		○		•			○		
REGION AS A WHOLE	●	○	○	●	●	●	●	●	○	○	•	•	•	•	○	○	○		○	○	○	○	○		○	•	•	○	•	○		•	●	○	●	○	○

CHAPTER 2 THE SETTING

The Blackstone and Vicinity planning area consists of the land that drains into the Blackstone, Ten Mile, Woonasquatucket, and Moshassuck Rivers. The area covers about 640 square miles (410,000 acres) and 30 cities and towns in south-central Massachusetts and northern Rhode Island.

Massachusetts:

Attleboro	Mendon	Seekonk
Auburn	Millbury	Shrewsbury
Blackstone	Millville	Sutton
Douglas	North Attleborough	Upton
Grafton	Northbridge	Uxbridge
Hopedale	Plainville	Worcester

Rhode Island:

Burrillville	Glocester	Pawtucket
Central Falls	Lincoln	Providence
Cumberland	North Providence	Smithfield
East Providence	North Smithfield	Woonsocket

Four major rivers – the Blackstone, Ten Mile, Woonasquatucket, and Moshassuck – drain the area. The Blackstone River originates in the southern part of Worcester, Massachusetts, and flows in a general southeasterly direction for 44 miles to its mouth in Pawtucket, Rhode Island. From this point, it becomes a tidal estuary and is known as the Seekonk River.

The topography of the Blackstone portion of the basin is generally hilly with higher elevations lying in the western portion. Because of short, steep tributaries in the upper reaches of the watershed and relatively longer ones in the lower reaches, there is a tendency for the tributary flows to synchronize with the crest on the main river, resulting in high floodflows. Glacial erosion and deposition left a number of sand and gravel deposits throughout the planning area.

The 22-mile Ten Mile River originates in Massachusetts near the Wrentham-Plainville town line and flows in a southerly direction through North Attleborough, Attleboro, and Seekonk, to East Providence. The Woonasquatucket River is slow and sluggish over its 19-mile length between North Smithfield and Providence. The Moshassuck River meanders in a southerly direction from Lincoln through Pawtucket to Providence where it joins the Woonasquatucket to form the Providence River. With the exception of some parts of the upper Ten Mile watershed, wetlands are not extensive and flood plain encroachment has been widespread.

Ground water is an important source of water for the Blackstone and Woonasquatucket-Moshassuck portions of the planning area, with aquifers distributed throughout the area. In the Ten Mile basin, nearly all water used for public and industrial supplies in 1970 was ground water.

The coastal shoreline of Providence Harbor is divided into two portions at the junction of the Providence and Seekonk Rivers. The westerly and easterly portions of the shoreline are each approximately 10 miles long, for a total of 20 miles. In general, the westerly shoreline includes sand and gravel, extensive concrete walls, rock revetments, private docks, and a large number of commercial wharves, piers, docks, and bulkheads. The easterly shoreline is primarily composed of gravelly materials, rock outcrops and sand and gravel bluffs, and includes several large oil terminals.

The area is a humid region with an average annual precipitation of about 43 inches, rather evenly distributed throughout the year. About half of this rain evaporates or transpires to the atmosphere through vegetation. The remaining half flows through the area's rivers and streams directly or as ground water seepage.

Nearly 20 percent of the people in the SENE region live in this planning area which includes the major cities of Worcester and Providence. Its population has risen only slightly from 810,000 in 1960 to 824,000 in 1970, making the area the slowest growing in the region. According to Study projections, it will climb slowly to 886,000 by 1990 and 920,000 in 2020. This anticipated growth is much lower than the average in SENE and for the United States as a whole. Within the planning area, however, the population is not so stable. Between 1960 and 1970, growth was rapid around the urban fringe, declining slightly in the central cities of Worcester, Woonsocket, Pawtucket, and Providence – thus reflecting nationwide urban trends.

Per capita income in 1969 averaged about $3400 (1967 dollars). While below the average for the SENE region, it is close to the national average. With a work force of over 370,000, the area employs just under 20 percent of the workers in SENE. Despite loss of over 12,000 manufacturing jobs between 1960 and 1970, over one-third of the workers in the planning area are employed in the manufacturing sector. The manufacturing sector is still the major employer in the area, having the same relative share as in 1960, and accounts for over 25 percent of all manufacturing jobs in the region. Other jobs were distributed principally among the retail trade, other services, and government sectors. In 1970, the nearly 100 workers in the mining sector represented one-fifth of the region's mining employment.

During the 1960's, a *net* total of nearly 11,500 new jobs were added, one of the smallest increases of all the planning areas. The greater number of new jobs – nearly 21,000 – were in the "other services" sector (primarily health, business, education, and the professional services), thus offsetting to an important degree the loss of manufacturing jobs.

Early in the Study, participants in a public workshop voiced a preference for correcting the problems of combined sewers, investigating methods for reducing water consumption, ensuring more effective wetlands protection, and expanding recreational opportunities closer to home.

Later, during the 90-day review period, over 275 state, regional, and municipal officials, federal agencies, and concerned citizens submitted comments on the Study's draft reports. The major comments are summarized in a Regional Report chapter, "Review of the Report."

There were several changes in the Blackstone Planning Area Report. Language was added to *Chapter 4* which reflects the City of Worcester's preference for development of ground water within municipalities prior to joining the City's water system. As a result of the concerns of local residents, *Chapter 5* suggests the review and updating of regulations regarding the siting of septic tanks. A recommendation for acquiring statewide access to Wallum Lake in Rhode Island was dropped from *Chapter 6* because of the potential conflicts with use of the lake for a hospital's water supply. Additions to *Chapter 6* are: a very cautious consent to the recreational use of storage water supply lands for limited recreation; mention of the need for state repair of mill dams, when the public interest is concerned (Massachusetts Water Resources Commission); the need to support municipalities which have state recreational facilities with some compensation (Douglas municipal officials); extension of the Ten Mile River Recreation complex to Massachusetts portion of the river basin (Office of the Mayor of Attleboro); additional details about the Blackstone River People's Public Park.

Several implications are suggested by the previous profile:

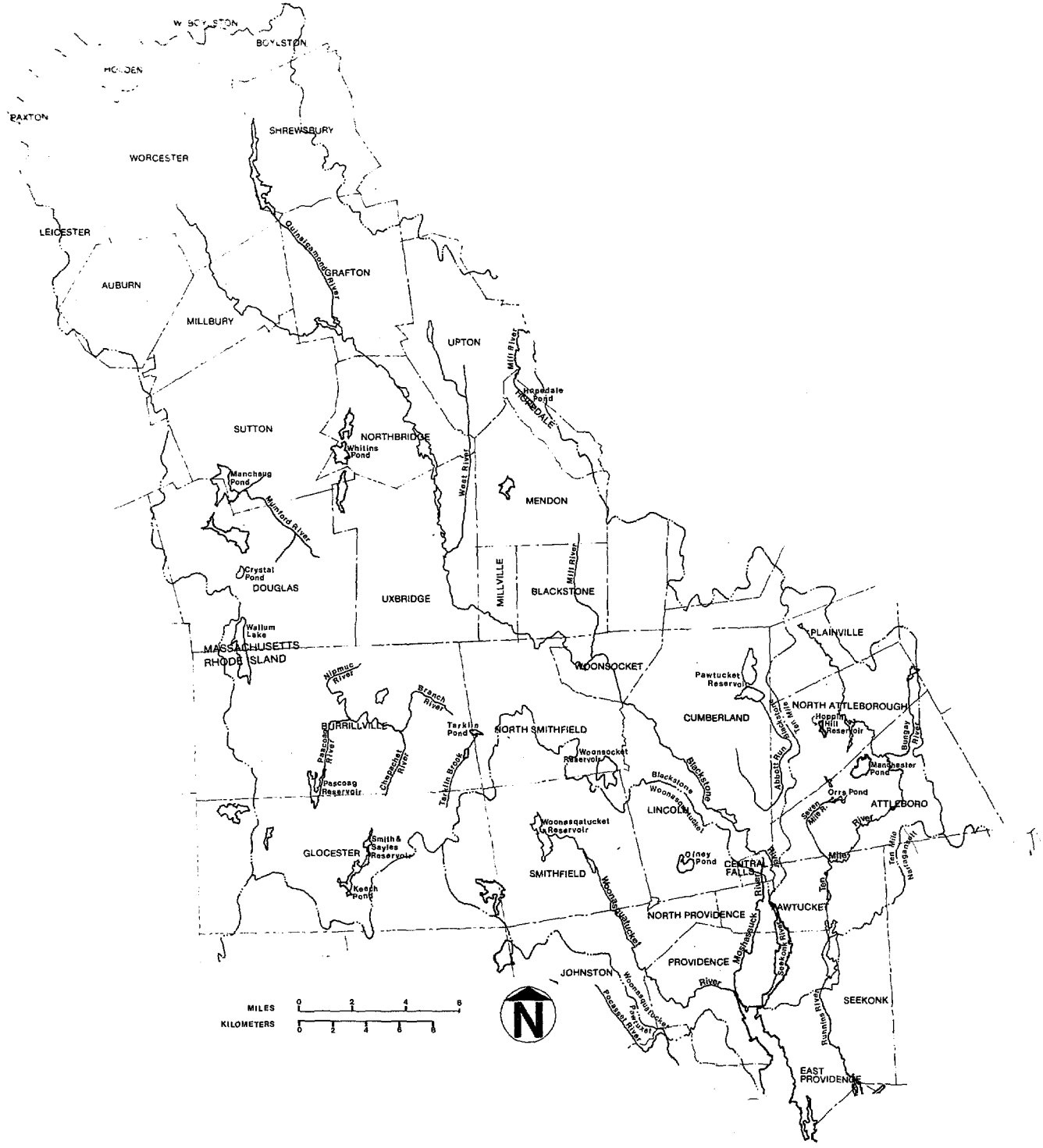
(1) Slow growth offers the opportunity to concentrate near existing heavily urbanized centers, thereby eliminating the threat of destroying critical resources.

(2) New development could be directed away from flood plain and wetlands areas, thereby reducing future areas subject to serious flood damages.

(3) Slow growth means the opportunity for many municipalities to continue to rely on protected ground water supplies, and keep down the need for developing more expensive surface water reservoirs by 1990.

(4) With one-fifth of the region's population, the planning area has the need to expand public recreational facilities to meet large levels of demand.

(5) Heavy dependence on manufacturing plus large urban centers along the major rivers have resulted in serious pollution that is difficult and costly to reduce.



NEW ENGLAND RIVER BASINS COMMISSION
BOSTON, MASSACHUSETTS

SOUTHEASTERN NEW ENGLAND WATER AND RELATED LAND RESOURCES STUDY

TOWNS AND RIVERS IN THE PLANNING AREA

FIG. NO. 2.1

CHAPTER 3 GUIDING GROWTH

The Blackstone, Ten Mile, and Woonasquatucket-Moshassuck river basins together contain the second largest population of the ten planning areas. The area ranks high in average density, containing both Worcester and Providence. But it also includes the largest acreage of unurbanized lands, particularly forests and agricultural lands.

Heavy population losses occurred in the major manufacturing cities in this planning area in the last decade, closely tied to the loss of jobs during that time. The suburban areas, however, grew relatively rapidly, urbanizing land at about the regional average rate. There is growing concern among the residents of the basins about where the development resulting from population and economic growth will occur, and how it will affect land and water resources. These resources form a part of the high environmental quality which has been shown to be vital to the region's economic health *(see Chapter 2 of the Regional Report).* A conclusion of the SENE Study is that the growth anticipated for this planning area can be accommodated without harming the existing environmental quality, and in a manner that most efficiently utilizes public infrastructure investment, as long as certain steps are taken to guide the location of development. This chapter describes the anticipated growth and the capacities of the resources to accommodate it. The last section includes strategies to guide growth in an economically and environmentally acceptable manner.

The Situation

Anticipated Growth

As we have seen in Chapter 2, the Blackstone, Ten Mile, and Woonasquatucket-Moshassuck river basins embrace the second largest of the planning area's populations, and moved from second to just barely third in population density between 1960 and 1970. However, large amounts of unurbanized land lie between the urban centers (it is the second largest planning area), accounting for the fact that the percentage of urbanized area (22 percent) is only just above the average for the SENE region. Of the 92,000 acres of urbanized land, 12,000 acres were in medium-intensity residential use of ½ to 1 acre, and another 4,000 acres were in low-intensity use of over 1 acre per unit. This means that 16,000 acres are in high-intensity urban uses such as commercial, residential with multi-and single-family units on less than ½ acre lots, public institutions, industrial, and transportation.

The population growth rate between 1960 and 1970 (two percent) was the lowest of all the areas, and the 31 percent increase in urbanized area was the next to lowest in the SENE region. But these figures mask the true picture. The four largest cities, major manufacturing centers, lost heavily in population during the decade, in an amount (43,000 persons) closely related to the loss of manufacturing jobs mentioned earlier. Some of the suburban areas actually grew relatively rapidly, with a total increase of 56,000 persons.

TABLE 3.1 MUNICIPALITY BY DEVELOPMENT PRESSURE: BLACKSTONE AND VICINITY PLANNING AREA

High	Medium-High	Medium-Low	Low
Attleboro	Glocester, R.I.	Auburn	Central Falls, R.I.
Cumberland, R.I.	East Providence, R.I.	Blackstone	Douglas
North Smithfield, R.I.	North Attleborough	Burrillville, R.I.	Grafton
Smithfield, R.I.	Plainville	Mendon	Hopedale
	Seekonk	Millbury	Millville
	Lincoln, R.I.	Shrewsbury	Northbridge
	North Providence, R.I.	Sutton	Pawtucket, R.I.
			Upton
			Uxbridge
			Woonsocket, R.I.
			Worcester
			Providence, R.I.

Note: Communities are grouped into levels of development pressure relative to other communities in the Study region and do not necessarily reflect local building activity.

The resulting land consumption rate in the *suburban* portions of this planning area (calculated by omitting the population and area of the four major cities) is .46 acres per person, almost exactly the SENE regional average rate of .50 acres per person. Between 1960 and 1970 agricultural land in the basin declined by 25 percent, from 68,000 to 51,000 acres (now comprising 13 percent of the area). The remaining undeveloped land in the planning area, including forests and wetlands, has been reduced by 6 percent (now 62 percent of the area). Water bodies make up some 3 percent of the planning area.

Between 1970 and 1990, population growth is expected to increase over the 1960 to 1970 level (see Chapter 2) before slowing down to a fairly stable population by 2020, assuming the present birth rate continues. If the projected 2020 population of 920,000 causes development of land at the average SENE land consumption rate of .5 acres per capita, only 48,000 of the planning area's undeveloped 240,000 acres will be urbanized.

The rates at which parts of the planning area will be urbanized will vary to some extent with the relative development pressures. These pressures were estimated for SENE communities on the basis of a formula using factors such as the rate of growth of residential, commercial, and other uses, the relative accessability of an area to employment and population in other parts of the region, and the availability of easily developable land. The process for grouping towns by development pressure is defined in the *Regional Report.* While use of other factors, such as recent building permits or land consumption rates, may produce different results, combining the factors used gives a useful indication of development pressure in the communities in the planning area, relative to all SENE communities. Table 3.1 shows the development pressure for the planning area cities and towns.

TABLE 3.2 THE SENE RESOURCE DEVELOPMENT CAPABILITY SYSTEM

CRITICAL ENVIRONMENTAL AREAS REQUIRING PROTECTION

Water Bodies (Category A), blue. [Includes estuaries, shellfish flats, and fish spawning areas.]
Priority Protection Areas (Category A), dark green: wetlands, well sites, beaches, and critical coastal erosion areas.
Other Protection Areas (Category B), light green: flood plains, class I and II agricultural soils, unique natural and cultural sites, [proposed reservoir sites and related watersheds, and upland erosion areas] excluding all "A" areas.

DEVELOPABLE AREAS REQUIRING MANAGEMENT, Excluding All A & B Areas

WATER RESOURCE LIMITATIONS
Aquifers and/or Recharge Areas (Category C_1) black dots: highest yield aquifers in each basin.

WILDLIFE AND SCENIC RESOURCE LIMITATIONS
Wildlife Habitat (Category C_3), black diagonal lines: best upland wildlife habitat other than publicly owned land and [commercial fishing grounds].
Landscape Quality Areas (Category C_2), black vertical lines: land characterized by high landscape quality other than categories C_1 and C_3.

SOILS RESOURCE LIMITATIONS
Ledge and/or Steep Slope (Category C_5), brown: land with slope greater than 15 percent and/or with rock near the surface.
Severe Septic System Limitations (Category C_4), orange: land with severe septic system limitations other than Category C_5.
Moderate to No Septic System Limitations (Categories F and G), yellow: land with moderate or no septic system limitations.

PREEMPTED USE AREAS

Urban Areas (Category E), gray: residential[5]/institutional, commercial and industrial development.
Publicly Owned Lands (Category D), beige: major public parks, forests, watersheds, and military lands.

Notes:

1/ All categories above, except those within brackets, are depicted on the development capabilities maps (plates 1, 2, 3).

2/ Categories in brackets are included to show where they would fit in the overall classification hierarchy, were they included on the plates in the pocket.

3/ All categories above, including those within brackets, are depicted on large-scale, unpublished maps available for inspection as part of the SENE Files.

4/ Categories C_1, C_2 and C_3 overlap with categories C_4, C_5, F, or G. Thus, Category C_3-C_4 is a wildlife habitat located on ledge or steep slopes.

5/ Mapped urban areas (Category E) include all-residential development, although the legend on Plates 1, 2, and 3 reads "residential areas on less than one acre lots."

Accommodating Growth

It is expected that almost all of the expected growth in the next 20 to 50 years will tend to occur on land not yet developed. Yet if the 240,000 unurbanized acres were to be urbanized indiscriminately, serious problems could result in the planning area. In order to assess the implications of growth, the resources were first identified and quantified. Classified according to development capability, these resources are grouped into three major categories as shown in Table 3.2, and mapped on Plate 3. The percent of the land and water resource categories in each planning area is shown on Table 3.3.

About 90,000 of the 240,000 unurbanized acres have been identified as being significant for protection of water and related land resources and sensitive to destruction by urban development. These are areas which the Study has classified as **Critical Environmental Areas** and mapped on the Development Capabilities Map, Plate 3.

The most fragile and valuable of these are Priority Protection Areas (Category A) in which any development threatens public health, safety, and welfare: water bodies, wetlands, well sites, beaches, critical erosion areas, estuaries, shellfish flats, and fish spawning areas. (Only the first three are found in this planning area in significant amounts.) Water bodies in the planning area need protection, by land use measures, from non-point source pollution. Polluted urban runoff is a major problem, particularly in the Providence and Worcester areas. Relatively few wetlands remain in the planning area in proportion to the total area. These are small and isolated pieces, distributed fairly evenly throughout the basins. Development threatens the existence of these wetlands, particularly in high and medium-high development pressure areas, and the cumulative effect of their loss would heighten flood damages. *Chapters 6 and 8 of this and the Regional Report* discuss the value of wetlands for flood storage, water supply, plant and wildlife habitat, water quality, and other purposes.

Other Protection Areas (Category B), which can retain their usefulness only under certain limited kinds of development, are: flood plains, prime agricultural lands, unique natural and cultural sites, proposed reservoir sites, and upland erosion areas. This planning area contains almost 40,000 acres of inland flood plains *(see Chapter 8 of the Regional Report).* In some of the urbanized areas, extensive development in flood plains has aggravated flooding problems. Communities with large flood plain areas

TABLE 3.3 PERCENT OF LAND AND WATER RESOURCE CATEGORIES IN EACH PLANNING AREA

Planning Area	Total (in 1000's of acres)	Percent (%) of Planning Area				
		Critical Environmental Areas			Developable Areas	Preempted Use Areas
		A	B	A & B	C, F, G	D, E
Ipswich-North Shore	274	19	13	32	34	34
Boston Metropolitan	421	14	9	23	30	47
South Shore	172	17	13	30	43	27
Cape Cod & Islands	378	10	23	33	32	35
Buzzards Bay	205	17	16	33	47	20
Taunton	351	19	22	41	37	22
Blackstone & Vicinity	410	10	11	21	38	41
Pawtuxet	180	11	7	18	41	41
Narragansett Bay	212	16	16	32	34	34
Pawcatuck	262	27	12	39	40	21
SENE	2,865	16%	15%	31%	36%	33%

Sources: See Methodology in the Regional Report.

include Attleboro, Pawtucket, Burrillville, Cumberland, Shrewsbury, Smithfield, North Providence, and Providence. Prime agricultural lands are particularly abundant in the central portions of the Blackstone basin, and in North Attleborough in the Ten Mile Basin; these communities also have many flood plains. Prime agricultural lands are targets for development; *the Regional Report, Chapter 3,* discusses the significance of the loss of these areas. The highest concentration of historic sites in Rhode Island is in this planning area, in Providence. Several cultural sites in Worcester are listed on the National Register. Unique natural sites are relatively scarce; a few are scattered in the East Providence area and in Burrillville and Glocester. The valued character of these sites would be damaged by incompatible development. Proposed reservoir sites are in Holden (Holden Reservoir) and Burrillville (Tarkiln and Nipmuc), as discussed in Chapter 4. Development of areas to become reservoirs, or their immediate watershed area, not only municipalities the cost of acquisition, but causes potential pollution problems.

The remaining unurbanized areas, comprising 154,000 acres (38 percent of the planning area), must be managed with varying degrees of regulation to protect certain values. These have been mapped on Plate 3 as **Developable Areas** requiring management (Categories C, F, and G) and include: ground water recharge areas, best upland wildlife habitat, high landscape quality areas, ledge and steep slope, severe septic system limitations (Category C), and moderate to no septic system limitations (Categories F and G).

A large proportion of the planning area is underlaid by moderate yield aquifer and, in the Ten Mile River basin, around the Bungay and Seven Mile rivers, by high yield aquifers. A number of communities are dependent upon these resources for local water supply, but urban runoff and highway salt have polluted areas in the Ten Mile and the Upper Blackstone basin. Recharge areas providing local water supply should be protected from both pollution and depletion caused by non-permeable coverage or installation of sewers.

Best upland wildlife habitat occurs in areas in the northern half of the Woonasquatucket-Moshassuck basin, along the Bungay River and the northwestern parts of the Ten Mile basin, and in areas scattered throughout the Blackstone basin. High landscape quality, defined by diversity and relief, is plentiful in the planning area. Large areas in a band along the Blackstone River, and the area around the headwaters of the Woonasquatucket (Smithfield) are examples.

The largest acreage in SENE of soils with severe septic system limitations (34,000 acres) are in this planning area. Large areas are in each community in the Ten Mile basin, in Lincoln, North Providence, and North Smithfield in the Woonasquatucket-Moshassuck basin, and in large parts of the upper and middle Blackstone basin. Density of development on these soils must be regulated according to availability of sewers. About 1,600 acres of ledge (exposed or within three feet of the surface) offer little development potential. Development on slopes of over 15 percent (such as those areas in North Attleborough near Hoppen Hill Reservoir, in Smithfield, and small areas elsewhere in the planning area) causes risk of erosion and septic system seepage to areas below.

Areas with moderate or no septic system limitations are suitable for any kind of development, subject only to restrictions according to availability of sewers where there is some degree of limitation in soil suitability.

Large areas of land (19 percent of the planning area) are unavailable for development because they are in public ownership (Category D). Most of the public lands are in open space, recreation, or water supply related uses.

Finally, as mentioned earlier, about 22 percent of the planning area has been already urbanized (Category E). Much of this area, though served by sufficient infrastructure, remains vacant, and could be available for additional development if problems preventing its development were overcome. But it is worth noting that developed areas can be used -- and further, that use and reuse of such land can be highly efficient. The combined amount of land unavailable for future development due to public ownership or existing development (41 percent) is a high proprotion of the planning area compared to the average for the SENE region (33 percent); only the Boston Metropolitan planning area has a higher proportion.

If development accommodating the population projected for this area were to be restricted entirely to the Developable Areas requiring management, and land was consumed at the average rate for the SENE region, there would be no shortage of land. The proportion of the planning area in Category A and B lands is relatively low (21 percent); only one planning area has a lower percentage. As a result, although a very high proportion is already pre-empted by development and public use, the proportion of developable lands is about average for the region. If one estimates the capacity of these lands to absorb the projected population by assuming continuation of the 1960-1970 land consumption rate for SENE of 0.5 acres per person, the population that could be accommodated is 308,000, far higher than the projected population increase of 97,000. Thus, it appears that development could be restricted from Critical Environmental Areas with little or no impact on development patterns in Developable Areas.

In addition to the land use problems facing the planning area due to resource capabilities of certain areas, there are problems in the siting of certain kinds of facilities and develop-

ments. A number of uses are vital for the economic growth of the region or the planning area, or to service the needs of the population, but they have significant impacts on water supply or quality. These facilities should not be located in Critical Environmental Areas, and their particular location within Developable Areas should be ascertained in accordance with carefully considered criteria. All three major basins in the planning area are major suppliers of construction aggregate for the SENE region. But frequently the best sand and gravel sites are aquifer recharge areas and care must be exercised to prevent pollution or depletion of the ground water. These are discussed further in Chapter 9. Similar considerations apply to solid waste disposal and large scale development. Transportation systems are among the facilities with large scale impact, both in their use of resources and in their influence on development patterns. Proposed transportation systems should be planned to avoid A and B areas wherever possible.

A large proportion of the population (74 percent) of the planning area is served by sewers, and proposals for additional sewer facilities would serve about 127,000 more people. This is more than the entire additional population projected for the area by 2020 (97,000). The loss of population and jobs in the major cities indicates the existence of large areas which have available infrastructure which is not being used. Encouraging development in areas where infrastructure – not only sewers, but also water and transportation – either already exists or is planned would increase its efficient use and decrease the necessity of additional investment. Clustering development is in itself more efficient, economically and environmentally *(see Chapter 3, Regional Report).* Greater concentration of development also increases the feasibility of rail and mass transit systems which are more efficient in use of land, energy, and air resources. Reducing the need for highways lessens highway salt pollution. Strengthening the relationship between development and infrastructure would also enable greater use of infrastructure investment to support growth policy. Location, type, intensity, and timing of development can be influenced by coordinated investment policies at local, substate, state, and federal levels of government. Following such an approach can decrease the cost of development of the taxpayer, an important consideration for this planning area whose average per capita income is below the regional average.

The Solutions

To take advantage of the Blackstone-Ten Mile-Woonasquatucket-Moshassuck planning area's potential for accommodating growth without significantly changing overall environmental quality, the following program is recommended: (a) Protect Category A Critical Environmental Areas; (b) Restrict development of Category B Critical Environmental Areas; (c) Manage development of Categories C, F, and G, Developable Areas including guiding growth to existing infrastructure.

A number of methods are available to carry out this program: existing state legislation, zoning, subdivision regulations, building codes, acquisition of fee simple, easements, or development rights. Within the context of existing methods, the actions below are recommended for municipalities, with the assistance of the R.I. Departments of Community Affairs and Natural Resources, and in Massachusetts, the Departments of Community Affairs and Environmental Management with regional planning agencies. Technical and financial assistance should be provided to review and adjust plans, ordinances, and by-laws, ensuring their compatibility with the following recommendations:

1. **Protect priority Critical Environmental Areas. Municipalities should prohibit development of Category A Critical Environmental Areas. (Priority Protection Areas). The appropriate uses of these resources include: water supply, fisheries production, limited recreation, or scenic and open space lands.**

Planning and zoning boards should protect **water bodies** from pollution by restricting adjacent development and by enacting subdivision regulations requiring stormwater runoff detention ponds. The recommendations in *Chapter 5 of this report* will also help to achieve the state's water quality standards. **Wetlands** should be protected through more rigorous enforcement of existing legislation at a local and state level *(Chapter 8 of the Regional Report details how the legislation can be improved; Chapter 6 of the Regional Report discusses kinds of assistance available to municipalities.* Municipalities, using Massachusetts Self-Help Funds, and/or private interests should acquire the most valuable wildlife wetlands and surrounding uplands which are mentioned in *Chapter 6 of this report.*

2. **Restrict development on other Critical Environmental Areas. Municipalities should restrict development on Category B Critical Environmental Areas (Other Protection Areas). Suitable uses to be considered for this category should include agriculture, extensive recreation, forestry, or, in some cases, with proper management, very low density residential use.**

Measures for protecting **flood plains**, described in depth in *Chapter 8 of the Regional Report,* include local flood plain zoning prohibiting development, discouraging or prohibiting reconstruction after substantial storm damages, and relocating some public facilities if structural protection is not available or practical. Structural methods required to remedy flooding problems in this planning area are described *in Chapter 8 of this report.* **Prime agricultural lands** should be protected by legislation enabling tax incentives, agricultural districts, and by acquisition of development rights for the highest priority lands *(see Regional Report, Chapter 3, for more details).*

Proposed reservoir sites and unique natural and cultural sites should be protected by acquisition of fee simple, easements, or development rights. *Chapter 4 of this report* describes recommendations for reservoir development in Burrillville. **Upland erosion areas** should be protected by local sediment and erosion control ordinances *(discussed in Chapter 8 of the Regional Report).*

The estimated 154,000 acres of Developable Areas require some management to retain the intrinsic natural functions which these resources perform. The SENE Study recommends:

3. **Manage growth on Developable Areas. Municipalities should manage growth on Category C resources and encourage growth on Category F and G resources, especially where infrastructure exists or is planned.**

It is worth noting that this recommendation deals with management of all developable areas, both within existing developed areas, and in areas yet to be developed. There are no developable areas in which management of some kind is not required.

On **ground water recharge areas,** communities should restrict housing densities so that septic systems will not endanger ground water quality. Densities requiring sewers should be allowed only after analysis of the economic and environmental feasibility of recharge maintenance techniques to prevent depletion of the aquifer. For details about development standards, refer to Table 3.4. Other ordinances and building codes should control coverage by impermeable surfaces, and require stormwater detention ponds with recharge from roofs, streets, parking lots, and driveways. Regulations and sound engineering practices should be used to minimize the effects of activities hazardous to ground water quality, such as sanitary landfill operation, highway deicing salt storage, industrial waste disposal, agricultural runoff, and sand and gravel mining below the level of the water table. On areas with **high landscape quality, best upland wildlife habitat,** and unsewered **soils with severe septic system limitation,** only development of very low density or in clusters should be allowed. Development that would tend to preempt the resource value of wildlife habitat and landscape quality should be carefully evaluated to ensure that adverse impacts are fully taken into account. **Steep slopes** should be protected from erosion by low density use. Development on **moderate limitation areas** should be regulated to correspond to the availability of sewers. Higher densities should be encouraged on **F and G lands,** as many C lands can support only very low densities.

Although local governments have much of the authority necessary to implement the concept of guiding growth based on resource capability, its implementation will be most effective if adopted as a matter of state policy. Many resources concerned extend beyond town boundaries, and additional funds and information exist at the state level.

The most expeditious way for the states to implement these concepts would be for their interagency policy councils to review and adopt as appropriate the policy issues suggested herein.

Rhode Island has taken a powerful step in this direction by putting together a comprehensive land use plan. To further strengthen the plan:

4. **Incorporate SENE Study findings into the Rhode Island land use plan. The Rhode Island Statewide Planning Program and State Planning Council should incorporate the SENE resource classification system into the land use policies and plan. Guidelines can be developed at the state, regional, and local levels of government.** *Chapter 10 of the SENE Regional Report describes several options for developing these guidelines.*

Massachusetts should continue its progress towards a comprehensive policy for guiding growth. This decision is most appropriately made by an interdisciplinary organization, and the SENE Study recommendation reads:

5. **Use SENE resource development capability analysis to guide future growth in Massachusetts. The Massachusetts Cabinet, with the active participation of regional planning agencies and municipal governments, should review and use, as a first step, the SENE Study's resource development capability analysis to develop a policy for guiding growth based on the concept that guiding growth with consideration of natural resources capability and suitability is desirable. Guidelines can be developed at the state, substate, or local levels of government.** *Chapter 10 of the Regional Report describes several options for developing these guidelines.*

6. **Accommodate growth where services already exist. The Rhode Island Planning Council and the Massachusetts Cabinet, in concert with towns, regional planning agencies, and state agencies, should establish policies to accommodate further development in already developed areas, and to permit maximum use of existing water, sewer, and transportation services. Planned**

TABLE 3.4 SUGGESTED* GUIDELINES FOR USE OF DEVELOPABLE AREAS SHOWN ON PLATES 1, 2, and 3

MAP COLOR	MAP PATTERN / Other Resource Limitations / Soils Limitations	NONE (color only) No other Resource Limitations	High Landscape Quality (Category C_2)	Upland Wildlife Habitat (Category C_3)	Aquifer and/or Ground water recharge areas (Category C_1)
YELLOW	Moderate to No Limitations for septic system disposal (Category F & G)	- PW & PS . Any I/C . Any Res. - PW only . Med. Intensity I/C . At least 1/2 ac/DU	If clustered on no more than 50% of area - - PW & PS . Any I/C . Any Res. - PW only . Med. Intensity I/C . At least 1/2 ac/DU Unclustered - . Low Intensity I/C . At least 1.0 ac/DU	If clustered on no more than 30% of area - - PW & PS . Any I/C . Any Res. - PW only . Med. Intensity I/C . At least 1/2 ac/DU Unclustered - . Low Intensity I/C . At least 1.5 ac/DU	If clustered on no more than 20% of area - - PW & PS . Any I/C . Any Res. - PW only . Med. Intensity I/C . At Least 1/2 ac/DU Unclustered - . Med. Intensity I/C . At least 1/2 ac/DU Unclustered or no PW & PS - . No I/C . At least 3 ac/DU**
ORANGE	Severe septic system limitations caused by conditions other than slope and ledge soils (Category C_4)	- PW & PS . Any I/C . Any Res. - PW only . Low Intensity I/C . At least 1.5 ac/DU	If clustered on no more than 50% of area - - PW & PS . Any I/C . Any Res. Unclustered or PW only - . Low Intensity I/C . At least 1.5 ac/DU	If clustered on no more than 30% of area - - PW & PS . Any I/C . Any Res. Unclustered or PW only - . Low Intensity I/C . At least 1.5 ac/DU	If clustered on no more than 20% of area - - PW & PS . Any I/C . Any Res. - PS only . Med. Intensity I/C . At least 1/2 ac/DU - PW only . No I/C . At least 3 ac/DU
BROWN	Ledge and/or steep slope greater than 15% (Category C_5)	- PW & PS . No I/C . At least 1/2 ac/DU *** - PW only . No I/C . At least 2 ac/DU	. No I/C . At least 3 ac/DU	. No I/C . At least 3 ac/DU	. No I/C . At least 3 ac/DU

* These are designed to provide a framework for designing guidelines of increasing specificity by state, regional, and local planners, and consultants more intimately knowledgeable with local circumstances.

** In many cases suggested guidelines for development, particularly for ground water, are estimates of probable safe controls made in the absence of greater knowledge of the effects of development on the pollution of aquifers.

*** Erosion control measures should accompany other restrictions on slopes over 15%.

Med. & Low Intensity - refers to water use/effluent discharge/building coverage

Clustering – refers to percent impermeable land surface area which may adversely effect the resource.

PW - Public Water Supply System
PS - Public Sewer System
I/C - Industry/Commercial
Res. - Residential
ac - acre
DU - Dwelling Unit

unit development and the cluster principle should also be encouraged in these areas to maintain as much as possible Critical Environmental Areas, forests, wetlands, and the best wildlife habitats.

The Regional Report also recommends establishment of a system for determining criteria for locations of developments of regional impact. This would be within the framework of the system designed to protect some critical areas and manage others, and would enable consideration of environmental and economic ramifications of siting decisions. Power plant siting problems in this planning area would be within the scope of this system. Consistent with siting criteria suggested for other facilities, highway planners and state officials should give special consideration to avoiding Critical Environmental Areas (Categories A and B) and using Developable Areas (C, F, and G) consistent with other needs for those same lands. Consistent with siting criteria suggested for other facilities of regional impact, highway planners should give special consideration to avoiding Critical Environmental Areas. *Details of this recommendation can be found in the Locating Key Facilities chapters of this and the Regional Report, and the chapters in the Regional Report on Guiding Growth and Strengthening the Management System for Natural Resources.*

Priorities

While the Study encourages all municipalities to undertake this strategy, the need is especially urgent in those with proportionately higher amounts of Critical Environmental Areas which will be under high or medium-high development pressure. Based on the discussion in The Situation section, these municipalities are: Cumberland, Lincoln, North Attleborough, Attleboro, and North Providence (see Table 3.1).

Implications

The impact of these recommendations on development patterns in the planning area, considering the large amount of area in each category and the projected population, would be positive both environmentally and economically. As previously noted, if the SENE land consumption rate continues in this planning area, all of the growth anticipated over the next 50 years could be accommodated on land and water resources capable of supporting that development with the fewest environmental costs. Excess infrastructure exists, or is proposed, which can serve the entire population growth for the next 50 years. Thus, the needs of the current and projected population can be met and economic opportunities can be furthered in a way that is fully consistent with resource capabilities and enhances both economic efficiency and environmental quality.

CHAPTER 4 WATER SUPPLY

The Blackstone, Ten Mile, Woonasquatucket, and Moshassuck planning area is an interstate group of river basins, encompassing cities and towns in both Massachusetts and Rhode Island. Each state's water supply outlook and the interstate water supply issues will be discussed separately in the four sections of this chapter.

Planning Considerations

In developing a program for satisfying future water supply needs in the Blackstone, Ten Mile, Woonasquatucket-Moshassuck planning area, a number of important considerations were taken into account. These included: (1) the feasibility of supplying demands with local sources; (2) the quality of the water to be provided; (3) the opportunities for regionalization; (4) the monetary costs of the supplies; and (5) the desired environmental setting of the area, as expressed by citizens at Basin Advisory Committee meetings and by the staffs of regional planning agencies.

If the resources are available, ground water is generally the most economical source of supply for a municipality to develop. Large regional water supply systems, such as that of the Metropolitan District Commission, and smaller regional systems, are generally more costly than ground water, but offer economies of scale which cannot be achieved by local supply systems. Local surface water systems are generally the most expensive sources of supply. Ground and surface water supplies are discussed in greater detail in *Chapter 4, Water Supply, of the Regional Report.*

UPPER BLACKSTONE RIVER BASIN, MASSACHUSETTS

Existing Resources. Worcester is the largest municipality in the Massachusetts portion of the basin and has the largest water supply system, delivering an average of 26 million gallons per day (mgd) in 1970. Furthermore, the Worcester system has interconnections with nine other municipalities and the Metropolitan District Commission. Ground water is the only source of supply for the other municipalities in the Upper Blackstone. Mendon and Millville rely entirely on private wells; the other towns (Auburn, Blackstone, Douglas, Grafton, Hopedale, Millbury, Northbridge, Shrewsbury, Upton, and Uxbridge) depend on local utilities.

1990 Demands and Opportunities. Using OBERS "Series E" population projections, the SENE Study has assumed an increase in per capita water consumption of one percent (1%) per year between 1970 and 1990. On the basis of these assumptions, and the use of maximum day demands for towns relying wholly on ground water, the Study has calculated the 1990 water demands for the Upper Blackstone municipalities (Table 4.1). While only Uxbridge has an existing ground water production capacity adequate for 1990 needs, all Massachusetts towns in the Blackstone basin except Worcester, Mendon, and Hopedale have favorable opportunities for developing some additional ground water. It has been suggested that Worcester, because of stabilized employment patterns and low development pressures, may have reached a leveling-off in per capita demand for water. Although existing sources are adequate (32.50 mgd from wells and reservoirs) to meet conservative 1990 demands (28 mgd), the City might have to develop additional sources to meet the demands of surrounding and more rapidly developing municipalities which are likely to look to Worcester to augment their current supplies. These municipalities could make connection to the Worcester system to meet their peak demands, if investigation of local ground water sources, recommended by this Study, shows that these sources are inadequate.

The *Central Massachusetts Comprehensive Water Supply Study* has identified the major options available to the Worcester area, which includes some towns outside of the Blackstone basin as well as all the Massachusetts municipalities in the basin. This study identified several surface reservoirs and diversions designed to increase the capacity of Worcester's existing reservoir system. If implemented, the projects could provide from 1.7 to 17.3 mgd to the system.

If local ground water resources in the other Massachusetts municipalities in this basin are not sufficient to meet their future needs, or if ground water development proves to be economically or environmentally unfeasible, new surface sources will have to be developed. Local surface water sources in Auburn, Blackstone, Grafton, Millbury, Northbridge, Sutton, and Upton will also have to be developed. However, as discussed in *Chapter 4 of the Regional Report,* local surface reservoirs are generally the most expensive of the water supply alternatives. Therefore, the SENE Study favors development of local ground water sources and connection to the Worcester system for supplementary supplies for municipalities in the Upper Blackstone basin.

For towns interested in ground water exploration and development, it should be recognized that little information exists on ground water availability in the Upper Blackstone. Plate 3 shows possible ground water aquifers and recharge areas. However, the information is based on a U. S. Geological Survey (USGS) reconnaissance study of stratified drift conducted specifically for the SENE Study. Aquifers probably represent not more than 50 percent of the units

mapped on that plate. The remainder of the mapped "aquifers" are probably recharge areas. In any case, additional detailed work will be necessary if a municipality in this basin is to develop additional ground water.

Recommendations. Because geologic conditions are favorable for ground water development in most of the municipalities in the basin, and because ground water is the most economical alternative for many of the towns, the following general recommendations from the Central Massachusetts Water Supply Study are endorsed:

1. **Survey ground water location, quantity, and availability in Upper Blackstone basin.** **All communities whose future water supply would best be provided from ground water sources should undertake continuing programs of well exploration, testing, and site acquisition. The objective would be complete evaluation of the ground water resources of those towns within a five-year period, and acquisition of well sites at least sufficient for projected 2020 demands in order to secure future options now. Wells requiring some water treatment should be acquired if they are the best available. This is especially important for Douglas, Blackstone, Northbridge, and Sutton because no connection with a regional system is anticipated. Moreover,**

TABLE 4.1 SUMMARY OF 1990 WATER SUPPLIES: UPPER BLACKSTONE RIVER BASIN

Municipality	Existing System (1970) Source	Safe Yield[a] mgd	1990 Average Demand mgd	1990 Design Demand[b] mgd	Proposed Additional Source of Supply
Auburn	Wells	2.6			Ground Water & Worcester Water Dept.
	Worcester Water Dept.	0.1			
		2.7	1.61	3.33	
Blackstone	Wells	0.9	0.63	1.43	Ground Water
Douglas	Wells	0.5	0.29	0.71	Ground Water
Grafton	Wells	1.8	1.77	3.63	Ground Water & Worcester Water Dept.
Hopedale	Wells	0.5	0.49	1.13	Hopedale Pond
Mendon	Private Supply	—	0.18	0.46	Ground Water
Millbury	Wells	2.0	1.90	3.86	Ground Water & Worcester Water Dept.
Millville	Private Supply	—	0.14	0.36	Ground Water & Uxbridge Water Dept.
Northbridge	Wells & Reservoirs	3.1	2.28	4.56	Ground Water
Shrewsbury	Wells	4.2	3.95	7.41	Ground Water & Worcester Water Dept.
Sutton	Wells	0.4	0.16	0.41	Ground Water
Upton	Wells	0.4	0.27	0.66	Ground Water & Worcester Water Dept.
Uxbridge	Wells	2.8	0.63	1.43	None
Worcester	Wells	5.7			
	Reservoirs	26.8			
		32.5	28.46	28.46	Phased surface water development

[a] Ground water yield is reported as pumping capacity of system

[b] Systems relying primarily on ground water sources must supply maximum day demands.

Blackstone may presently be developing its last available ground water site.

In addition, a continuing program should be authorized by the General Court to produce a survey by the Water Resources Commission, in cooperation with the U. S. Geological Survey, of ground water location, quantity, and availability in the region for the purposes of:

- Providing information to assist towns design their exploration programs for well sites.
- Providing information to assist regional agencies in evaluating future needs to supplement ground water.
- Providing data necessary for the regulation, protection, and preservation of ground water resources.

This program should employ geological studies, seismic investigations, and test drilling. Funding should come from the Massachusetts Water Resources Commission, the USGS, and the municipalities involved.

A response from the City of Worcester strongly supports such a thorough survey of the Upper Blackstone area's ground water, using geohydrological or seismic survey methods, and suggests a detailed program of investigation.

2. **Meter all water use in the Upper Blackstone for planning system management.** All water works in the basin should adopt a policy of metering all water use to discourage waste by users, to allow determination of leakage from mains, and to provide data for planning system management.

3. **Investigate advantages of closer water system cooperation in Upper Blackstone.** Public water works agencies in the planning area should investigate advantages and economies which may be possible through closer cooperation, including sharing technical personnel and facilities, common purchasing, etc.

4. **Increase activities in the field of water supply, public information and education in Upper Blackstone.** All water supply agencies in the basin should increase their activities in the field of public information and education to facilitate public acceptance of actions to preserve and protect water sources, upgrade systems, and raise the capital necessary to provide for increases in water supply.

More specifically, although Worcester's future water needs seem to be leveling off and the additional 1990 needs of surrounding SENE communities, even without additional ground water development, are relatively small (approximately 8 mgd for Auburn, Grafton, Millbury, Shrewsbury, and Upton), the SENE Study makes the following recommendation:

5. **Expand Worcester's existing surface water systems.** Worcester should plan to expand its existing surface water systems within the next five to ten years. It should acquire the land and rights to preserve its future options now. Phased development of several smaller projects with treatment at a central facility will provide flexibility in meeting future water needs and costs, as well as operational economies of regionalized collection and treatment. However, a complete economic and environmental assessment of each project should immediately precede any additional expansion of the system.

Furthermore, the SENE Study recommends:

6. **Establish connections to Worcester system in Auburn, Millbury, Grafton, Shrewsbury, and Upton.** If thorough surveys of ground water availability show that additional sources will not meet their needs, connections to the Worcester system should be established in Auburn, Millbury, Grafton, Shrewsbury, and Upton. These towns should also develop additional ground water in their own systems.

In the near future, only Millbury and Shrewsbury are expected to require significant amounts of water from Worcester. However, the Study recommends hookups for all five municipalities to avoid individual municipal expenses of developing the capacity to meet their maximum day demands. In addition, such connections will assure these communities of the future availability of water at a reasonable cost. Additional ground water development and withdrawal by communities on the upper reaches of the Quinsigamond River should be managed to avoid serious depletion of the flows of that river.

Another SENE Study recommendation is:

7. **Explore and develop ground water sources in the Upper Blackstone municipalities. Additional ground water exploration and development should occur in Blackstone, Douglas, Mendon, Northbridge, and Sutton. Provision should be made to preserve resources for use until 2020 wherever possible. As prime local resources become fully developed, it may be increasingly necessary to treat future wells for iron and manganese.**

In addition:

8. **Pursue local surface water development only where necessary in the Upper Blackstone. Local surface water development in the above towns should be pursued only where ground water options do not exist and only after complete economic and environmental impact studies.**

9. **Develop interconnection with Uxbridge to serve Millville. Millville should establish an interconnection with Uxbridge to supplement its limited local supplies.**

Because the existing ground water resources of Hopedale (northern Mendon) are used at capacity, and because surface water treatment is available, the SENE Study recommendation is that Hopedale:

10. **Investigate development of Hopedale Pond as a water supply source. Proposals for the development of the north end of Hopedale Pond should be investigated by the municipality for its feasibility as a source of water supply.**

Although this pond is presently used for recreation and has a weed control problem, it has been considered to have potential as a source of water supply if it is expanded by constructing a low dam across a narrow neck of water near the center of the pond. Hopedale has recently hired a consultant to determine the economic feasibility of this project.*

LOWER BLACKSTONE RIVER BASIN, RHODE ISLAND

There are seven municipalities in the Rhode Island section of the Blackstone River Basin. The Pawtucket Water System, which met a demand of 15.86 mgd from four municipalities in 1970, is the largest supplier. The residents of Glocester, on the other hand, have no public system, and currently obtain their water from individual private wells.

The urban municipalities in the Lower Blackstone area – Woonsocket, Central Falls, and Pawtucket – are experiencing low development pressures, and their daily water consumption is leveling off because of employment stabilization in the industrial sector. Of the remaining towns, Burrillville, North Smithfield, and Cumberland have moderate and high development pressures and are expected to expand their water service areas. Glocester is expected to establish two small service areas.

Existing water supply systems and projected demands for Lower Blackstone cities and towns are shown on Table 4.2.

Urban Systems: Pawtucket, Central Falls, Cumberland, and Woonsocket

The city of Pawtucket, with a 1970 water demand of 11.36 mgd, was almost totally served by the Pawtucket Water Supply Board. This system also provided 0.35 mgd to North Providence and 1.39 mgd to Cumberland in supplementary supplies in 1970. However, North Providence is now entirely served by the Providence Water Supply Board. The Pawtucket Water Supply Board also provided an average of 2.76 mgd to Central Falls, meeting its total demand.

The Pawtucket system uses a combination of surface and ground water sources. The Abbott Run watershed in Cumberland is impounded at Diamond Hill and Arnold Mills Reservoirs. Recently, the Diamond Hill Reservoir storage capacity was increased by 1.169 billion gallons. City officials estimate that these impoundments have increased the dependable yield of the reservoir by 3.5 mgd, for a total of 15.7 mgd from surface sources. The yield of Pawtucket's wells is about 5.0 mgd. The system's total safe yield of 20.7 mgd should be sufficient to supply the 1990 demands

*Alonzo B. Reed, Inc., Report to the Central Massachusetts Regional Planning Commission and the MDC Relative to the Central Massachusetts Comprehensive Water Supply Study (June 1973), p. 169.

of Pawtucket and Central Falls, as well as the needs of Cumberland, which are not met through that community's local sources. The total 1990 demand on the system of these three municipalities is estimated to be 16.6 mgd.

In 1970, Cumberland's water demand was 3.21 mgd, an amount supplied to 92 percent of the total population through three public systems. The Town of Cumberland Water Department supplied 1.81 mgd, while the City of Pawtucket Water System and the City of Woonsocket Water Department supplied 1.39 mgd and 0.01 mgd, respectively. Three wells, with a combined pumping capacity of 2.92 mgd, and Sneech Pond, with a yield of 0.60 mgd, constitute Cumberland's local sources.

As is true of many supplies along the Blackstone River, Cumberland's municipal wells are troubled with increasing levels of iron and manganese. Although substantial ground water resources remain to be explored and developed within the town, the Rhode Island Department of Health has notified town officials that no further development will be approved until iron and manganese removal equipment has been installed to treat present and future supplies. Thus Cumberland must choose between treating local ground waters and seeking additional supplies from outside sources (i.e. Pawtucket). Local autonomy would be assured and economic benefits would result from the installation of iron and manganese removal facilities and the efficient use of local ground water resources.

The Woonsocket Water Department served 99 percent of Woonsocket's population and 35 percent of the population in North Smithfield in 1970. The remaining demand in both communities was supplied through individual private wells. The system also provided a small amount of water to residents in Cumberland.

The 1970 demands of 4.81 mgd from Woonsocket and 0.34 from North Smithfield were met with the use of surface and ground water supplies. Two reservoirs with a safe yield of

TABLE 4.2 SUMMARY OF 1990 WATER SUPPLY: LOWER BLACKSTONE RIVER BASIN

	Existing System (1970)		1990 Average Demand (mgd)	1990 Design Demand[b] (mgd)	Proposed Additional Source of Supply
Municipality	Source	Safe yield[a] (mgd)			
Burrillville	Wells	1.9			
	Reservoir	0.2			
		2.1	0.85	1.88	None
Central Falls	Pawtucket	2.76	2.84	Same	Tarkiln Reservoir
Cumberland	Wells	2.9			Treated ground water and Tarkiln Reservoir
	Reservoir	0.6[c]			
		3.5	6.91	12.09	
Glocester	Private supply		0.54	1.24	Ground water and Providence Water Supply Board
No. Smithfield	Woonsocket	0.34	0.77	Same	Ground water
Pawtucket	Wells	5.0			Tarkiln Reservoir
	Reservoirs	12.2			
		17.2	12.04	Same	
Woonsocket	Wells	1.9			Treat Harris Pond; Tarkiln Reservoir
	Reservoirs	8.5[d]			
		10.4	5.14	Same	

[a] Ground water yield is reported as pumping capacity of system.

[b] Systems relying primarily on ground water sources must supply maximum day demands.

[c] Cumberland is also served by the City of Pawtucket Water System (1.39 mgd) and the City of Woonsocket Water Department.

[d] This figure includes 5.0 mgd from the Mill River-Harris Pond source. Unless this source is treated it cannot be considered as a dependable source of supply.

3.5 mgd, the Mill River-Harris Pond source, which has a safe yield of 5.0 mgd, and two wells with a safe yield of 1.85 mgd raise the total supply to 10.35 mgd. However, the Mill River source is presently held in reserve due to periodic taste and odor problems. Estimated 1990 demands on the Woonsocket system total approximately 5.5 mgd. No new sources will need to be developed to supply these additional demands, but treatment of the Harris Pond source will be required.

In case the 1990 demands of Pawtucket, Central Falls, Cumberland, and Woonsocket should prove greater than anticipated, and in preparation for meeting long-range water needs, careful consideration should now be given to developing additional sources of supply for this area.

The most suitable opportunities for development in the northern part of Rhode Island include a combination of different levels of development of the Nipmuc, Tarkiln, Chepachet, and Wilson reservoir sites and certain ground water deposits. Although these sources represent a total theoretical yield of 35 to 40 mgd, it is unlikely that this yield could be completely realized – all the reservoirs are located in the Burrillville area and have interrelated sources of supply, the development of one site would preclude full development of the others.

Because the Chepachet and Wilson reservoir sites are located adjacent to fairly densely built-up areas, they would be difficult to protect without condemning many existing structures and residences. This would tend to drastically increase development costs of these reservoirs. For this reason, the Chepachet and Wilson sites are assigned a relatively low development priority.

The Tarkiln Brook site has been regarded as a major future development for this part of the planning area. Although the expected safe yield of a reservoir on this site is relatively small, when used in conjunction with the Nipmuc River, its total yield would be more than enough to justify its development. The location of this particular site is also very much in its favor. It is further to the east and hence closer to the major distribution systems than most of the other potential sources. Although its present water quality is classified as "B", the site is in a rural area, and the acquisition of surrounding land to assure its future protection is much less expensive than other alternatives. These facts, combined with the post-1990 needs of Pawtucket, Central Falls, Cumberland and Woonsocket, give the acquisition of the Tarkiln reservoir site a high priority.

The Nipmuc River, because of its estimated safe yield, and the fact that its proposed classification is of the highest quality, must also be considered as having a high priority for development. The Nipmuc has additional appeal as an alternative because it can be developed in a modular fashion in conjunction with the Tarkiln Brook Reservoir. It should be noted that under the Corps of Engineers Pawcatuck-Narragansett Bay Study the Nipmuc is being considered for multi-purpose flood control function, in addition to water supply. Initial 1990 demands, even if larger than anticipated in this Study, could be met by the Tarkiln's 5.4 mgd capacity alone. By acquiring the Tarkiln and Nipmuc resources now, long-range options for the Pawtucket and Woonsocket systems would be available at considerable savings.

Other potential resources in the area include the existing Smith-Sayles, Keech, Pascoag, and Slatersville Reservoirs. The first of these promises sufficient yield, but because all of the reservoirs are located in relatively built-up areas, protection of the quality of the water would seem to be both difficult and expensive. For these reasons, these last three sources are not assigned a high priority for development.

Another alternative which is open to the municipalities is to limit increasing water consumption patterns. The existing supply system is well developed and could allow for considerable growth before the towns actually run out of water. However, this course of action alone would negate the option to purchase resources now that could be used for meeting long-range needs. Because these resources also have multi-purpose benefits as sources of recreation and aesthetic value, their procurement now is recommended, in conjunction with efforts to slow the currently increasing rate of water consumption.

The SENE Study therefore makes the following recommendations:

11. **Acquire Tarkiln and Nipmuc Reservoir sites by 1990.** **The Water Resources Board should petition the Rhode Island General Assembly to approve the Tarkiln-Nipmuc projects and allow for the acquisition of these resources in the near future. It is further recommended that the Nipmuc diversion project not be constructed until after 1990, and then only after a reassessment of the water needs of the system has been made.**

12. **Plan for protection of reservoirs serving Pawtucket, Cumberland, and Woonsocket.** **Plans should be made for protection of the reservoirs now serving Pawtucket, Cumberland, and Woonsocket, as development pressures in these areas are expected to increase.**

13. **Construct iron and manganese removal facilities for Cumberland's sources.** **Cumberland should take action in the very near future to construct iron and manganese removal facilities with sufficient capacity to**

treat existing and potential ground water sources. A program of ground water exploration and development similar to that recommended for the Upper Blackstone municipalities *(recommendation 1, above)* should also be undertaken.

14. **Make plans to treat and use Harris Pond to augment Woonsocket existing supplies. Woonsocket should investigate what additions to its present treatment facilities may be necessary to use the Harris Pond source.**

Rural Systems: North Smithfield, Burrillville, and Glocester

As mentioned above, approximately 35 percent of North Smithfield's population was served by the Woonsocket Water Department in 1970, using an average of 0.34 mgd. The remainder of the town was served by individual wells.

By the year 1990, it is expected that medium-density residential development will occur around the Slatersville area in North Smithfield. A ground water aquifer in that area, possibly having a yield of 5.5 mgd, could be developed to supply the needs of this development. Development of wells for this purpose might use less than one-fifth of the total yield of the aquifer. Therefore, it is felt that adverse effects on nearby pond and stream levels will be relatively small. The Study recommendation is as follows:

15. **Explore and develop additional ground water in North Smithfield. North Smithfield should undertake a program of ground water exploration and development as outlined for Upper Blackstone municipalities.**

The town of Burrillville currently has about 59 percent of its total population served by three of its seven supply systems. Two of them, the Harrisville Fire District and the Pascoag Fire District use ground water as sources of supply The Harrisville system has three wells with a combined safe yield of 0.87 mgd, while the Pascoag system uses three wells with a safe yield of 1.06 mgd. In 1970, these systems provided 0.15 mgd and 0.20 mgd respectively. The present available yields from the systems operating in Burrillville seem to be adequate to satisfy the anticipated municipal water demands up to the year 1990.

In addition to the two systems mentioned previously, the Zambarano Hospital, in the northwestern corner of Burrillville, has a private system for its needs. The system uses Wallum Lake as a source of supply (safe yield is 0.20 mgd). Future needs of the Hospital system cannot be easily determined, but if rapid expansion is anticipated, the possibility of increasing storage facilities of the Wallum Lake or developing other sources should be studied. Slow increases in demand may not require an additional source of supply until the year 1990. The SENE Study recommendation is to:

16. **Consolidate the existing water systems serving Burrillville. The existing water systems serving Burrillville should be consolidated to facilitate orderly growth.**

Public water supply service is being considered by the Chepachet area of Glocester. This new system may be best served by ground sources developed around the area. Because of the experience and expertise of the Pascoag Fire District in Burrillville, it is suggested that this system develop the additional ground water sources required to serve Chepachet. The Harmony area, located in the southeastern corner of Glocester, is expected to be served by the Providence Water Supply Board. This seems to be the most viable plan for Glocester, since the two areas are distant from each other, making transmission of water from the Chepachet area a costly option. The following recommendation is made:

17. **Develop additional ground water to serve Chepachet section of Glocester. The Pascoag Fire District in Burrillville should develop additional ground water sources required to serve the Chepachet area of Glocester. The Harmony section of Glocester should be served by the Providence Water Supply Board.**

TEN MILE RIVER BASIN

In the Ten Mile River Basin, four of the five communities are located in the State of Massachusetts – Attleboro, North Attleborough, Plainville, and Seekonk – while East Providence is located in Rhode Island. Attleboro is a high development pressure town while the rest are moderately high; therefore considerable growth is expected in this basin. East Providence has abandoned the Ten Mile River and wells as sources of supply and now obtains all its water supply (5.5 mgd in 1970) from the Providence Water Supply Board. Therefore, East Providence will be discussed in the Woonasquatucket-Moshassuck section of this chapter.

Attleboro, with an average 1970 demand of 7.56 mgd, uses both surface and ground water sources for supply, and its water system is connected with both the North Attleborough and Seekonk systems. It is estimated that about 60 percent of Attleboro's municipal demand is due to industrial water requirements, which account for a high level of per capita consumption. In addition, about 5.0 mgd of industrial water demand is supplied by the industries themselves.

North Attleborough's water system relies on ground water

sources for supply, serving an average of 2.02 mgd in 1970, and is interconnected with Attleboro and Plainville. Plainville, with a 1970 average demand of about 0.61 mgd, obtains its water supply from local wells within the Taunton River basin and is connected with the North Attleborough system. Seekonk also relies on ground water and in 1970 had a water demand of 0.99 mgd. The Seekonk system has an interconnection with the Attleboro system.

Developed safe yield in the Massachusetts towns of the Ten Mile basin in 1970 was approximately 20 mgd. Average demands on water supply resources in the same year were approximately 11 mgd, and although there appears to be a surplus of resources for future growth, the four Massachusetts towns will have to meet a projected basin maximum day demand of 25 mgd by 1990.

Although ground water is the most economical source of supply for a municipality to develop, a substantial portion of the ground water resources of the Ten Mile Basin have already been developed, and much of the remainder is of low quality and will require considerable treatment. A general recommendation made for the Blackstone basin, however, also applies to the Ten Mile towns: even with treatment, ground water development is cheaper than local surface water development.

Only Plainville and Seekonk are reported to have sufficient developable ground water resources within their boundaries to meet projected 1990 water demands (using a one percent increase in per capita consumption per year). The remaining communities will have to seek a more expensive out-of-town source or go to surface water supplies.

Attleboro, faced with deteriorating water quality in its surface sources (Seven Mile River) and some of its ground sources (along the Bungay and Ten Mile Rivers), is unlikely to find additional ground water of sufficient quality and quantity within the town to justify municipal development. A report recently prepared for the city suggests that an adequate amount of water can be developed from the Wading River and local wells to meet Attleboro's water needs up to 1990. However, negotiation of an agreement with the City of Taunton to supply future additional demands from its Lakeville Ponds source would assure Attleboro of an adequate amount of water even beyond 1990. A proposal to create a regional water system around the present Taunton supply has been discussed in the *Taunton Planning Area Report.*

Having developed ground water resources in the Ten Mile and Bungay River basins to their reasonable capacity, North Attleborough has received approval from the Massachusetts Department of Environmental Quality Engineering to develop an additional safe yield of 1.5 mgd from ground sources in the Abbott Run watershed. These new sources will increase the system's total available safe yield to approximately 6.0 mgd, just short of its projected 1990 high population maximum day demand (6.33 mgd). As a water supply connection currently exists between the Attleboro system and North Attleborough, an agreement with Taunton to provide peak water demands might be sought. Recommendations which are flexible in meeting long-range needs, and less reliant on the marginal ground water reserves of the basin to meet peak demands, include the following:

18. **Develop additional ground water in Plainville, Seekonk, and North Attleborough. Plainville, Seekonk, and North Attleborough should develop additional ground water sources to meet 1990 and long-range needs.**

19. **Supplement Attleboro supplies through the Taunton regional system. Attleboro should enter into an agreement with the city of Taunton within the next five years for the purpose of supplementing its 1990 and long-range water supplies.** *(See Taunton Planning Area Report for description of proposed regional system.)*

20. **Establish an emergency connection between North Attleborough and Taunton. North Attleborough should establish an emergency connection with the proposed Taunton system through the town of Attleboro.**

Table 4.3 lists the existing water supply systems and 1990 demands for municipalities in the Ten Mile River Basin.

WOONASQUATUCKET — MOSHASSUCK RIVER BASIN

In the Woonasquatucket-Moshassuck River basin, three of the four communities – Providence, North Providence, and Smithfield – are supplied primarily by the Providence Water Supply Board. The fourth community, Lincoln, has its own water system, using wells along the Blackstone River.

Smithfield

Smithfield has its own distribution system, but its entire supply is obtained from Providence. Two small areas of Smithfield are served by the East Smithfield Water District and the Greenville Water District. However, each district obtains its water from the Providence system. As previously mentioned, approximately 10 percent of the North Providence population had been served by the Pawtucket Water Supply Board in 1970, but now the municipality is wholly

served by the Providence system, either directly or through the East Smithfield Water District. For Smithfield, the SENE Study makes the following recommendation:

21. **Consolidate three systems currently serving Smithfield. The three systems which currently serve Smithfield (Smithfield Fire District, and the Greenville Water District) should join to form one municipality-wide system in order to allow for more purposeful and more efficient expansion of public water service into the developing areas of the town, as suggested by the Rhode Island Statewide Public Water Supply Plan.**

Providence Water System

Although Providence has not experienced the rapid growth rates seen in other parts of the SENE region, the metropolitan area in which it is set, including most of the area which the Providence Water Supply Board serves, has grown by 11 percent between 1960 and 1970, and the per capita water demand has also grown. In 1970, the Providence water system served a total amount of 55.22 mgd, of which approximately 34.4 mgd, or 63 percent, went to the Woonasquatucket-Moshassuck River basins. The City of Providence used about 31.41 mgd, while Smithfield, through its various water systems, used 0.92 mgd. North Providence, through the Providence and East Smithfield systems, used 2.07 mgd. All water supplied by the Providence Water Supply Board was obtained from the Scituate Reservoir Complex (estimated safe yield of 72 mgd), located in the Pawtuxet planning area.

Assuming that the Providence system will continue to service these towns as well as East Providence in the Ten Mile Basin, Cranston and Johnston in the Pawtuxet basin, and Warwick, Barrington, Bristol, and Warren in the Narragansett Bay planning area, a 1990 water demand of 80 mgd has been estimated using a current trends projection (a one percent annual increase in per capita consumption). A breakdown, by town, of maximum anticipated water demands on the Providence system is presented in Table 4.4.

A number of alternatives exist for expansion of the Providence system to supply its immediate and long-range needs. Of high priority in the state plan is the development of the Big River for water supply use (from the Report to the Water Resources Board on a Development Plan for the Water Supply Resources of Rhode Island). Other alternative plans suggest development of the Wood River Resource, development of the Big River Reservoir in conjunction with flood skimming of the Flat and the

TABLE 4.3 SUMMARY OF 1990 WATER SUPPLY: TEN MILE RIVER BASIN

Municipality	Existing System (1970) Source	Safe Yield[a] (mgd)	1990 Average Demand mgd	1990 Design Demand[b] (mgd)	Proposed Additional Sources of Supply
MASSACHUSETTS					
Attleboro	Wells-Bungay R.	2.00			Taunton Regional System
	Wells - Wading R.	2.75			
	Wells - Orr's Pond	5.00			
		9.75	11.29	Same	
N. Attleborough	Wells - Plainville	4.50	3.33	6.33	Ground water & Taunton Regional System
Plainville	Wells	3.16[c]	1.76	3.61	Ground water
Seekonk	Wells	4.00	1.88	3.82	Ground water[d]
RHODE ISLAND					
E. Providence	Providence Water Supply Board	5.51	7.75	Same	Providence Water Supply Board

[a] Ground water yield is reported as pumping capacity of system.

[b] Systems relying primarily on ground water sources must supply maximum day demands.

[c] Includes a well completed in 1973, with an estimated total safe yield of 1.44 mgd.

[d] Treatment for manganese removal may be required for ground water resources developed in the area of Central Pond.

Moosup Rivers, and development of the Buck's Horn Brook Reservoir. Because contamination problems are likely to arise in the rivers that would be skimmed, the proposed development of the Big River Reservoir (26 mgd) was given the highest priority for development by the State. This alternative was strengthened by the fact that the necessary land for the project has already been acquired.

It appears that the development of the Wood River Reservoir can be postponed or perhaps even avoided. The SENE Study's demand projections indicate that sources of the Providence system need only be expanded by 8 mgd by 1990. This means that the Wood River Reservoir will not be required for some time after that date. There are social costs involved in this project because the Wood River has exceptional scenic and recreational value. *(see Chapter 6 of Pawcatuck Planning Area Report).* In addition, the reservoir impoundment might partially negate the use of ground water resources for the Kent County system, as discussed in the *Pawcatuck Planning Area Report,* unless precautions were taken. By the time the water from the Wood River Reservoir might be needed, significant advances in technologies such as desalination may provide economically feasible alternatives to the reservoir.

Options also exist for the administrative structure of future development proposals. In Rhode Island, the lead role in acquiring water supplies rests with the Water Resources Board. The Board, however, does not have sufficient capacity to finance the large initial project on the Big River. It is dependent on public referendum and the legislature for interim appropriations, and these appropriations have not been acted on favorably in recent years. In fact, voters in a November 1974 referendum defeated a $3 million bond issue for design and engineering of the reservoir. The Governor has made water supply one of his top priority considerations, however, and, fortunately, further action on the reservoir will be forthcoming.

Rhode Island could allow the Providence Water Supply Board to develop and manage the Big River Reservoir. However, the state would thus be giving up its authority to allocate water supplies to municipal service areas. In addition, the state would also lose its power to control the watershed lands for multi-purpose uses, to manage surface and ground water in a compatible program, and to set water prices for the general good of the public. Therefore, the SENE Study endorses the conclusions of a recent consultant's report that "a definitive statement of economic and social objectives for water resource development in Rhode Island should be established as a policy input to planning at the state level," (Water Supply Management Alternatives to Rhode Island, Final Report by TASC, 31 October 1973, p. 2-11). This policy should establish the uses of the Big and Wood Rivers, including their surface water potential, ground water resources, and recreational opportunities.

The SENE Study makes the following recommendation:

22. Petition the General Assembly to approve construction of the Big River Reservoir. The Water Resources Board should petition the Rhode Island General Assembly to approve construction of the Big River Reservoir project. The administration of this supply, either through the Providence Water Supply Board or the Water Resources Board, should assure multi-purpose use of the proposed diversion sites on the Wood River and should assure the use of the ground water resources of the Wood River Valley in order to minimize costs of water supply and to

TABLE 4.4 MAXIMUM ANTICIPATED DEMANDS FOR PROVIDENCE WATER SUPPLY SYSTEM (in mgd) - - 1990

Basin	Municipality	Demand
Blackstone	Glocester	0.25
Ten Mile	East Providence	7.75
Woonasquatucket-Moshassuck	North Providence	4.32
	Providence	33.81
	Smithfield	2.10
Pawtuxet	Cranston	15.04
	Johnston	2.96
	Scituate	0.20
Narragansett Bay	Warwick	11.72
	Barrington	1.24
	Bristol-Warren	0.28
Total		79.67

postpone for as long as possible any surface water impoundments on the Wood river.

A third possible form of administration suggested during 90 day review is a metropolitan water authority composed of representatives from cites and towns serving Providence.

These recommendations are made since competition from alternative sources such as wastewater recovery and desalination may be approaching a stage of development that might seriously challenge the need for further surface water development after the Big River Reservoir.

Lincoln System

Lincoln, which has its own ground water supply, used an average of 2.66 mgd in 1970, requiring nearly 50 percent of this figure for industrial use. Estimated 1990 demands indicate a maximum day use of 6.4 mgd, making Lincoln's present sources inadequate to satisfy future needs. However, the town has a favorable chance of meeting these needs by further development of ground water, although treatment for removal of manganese will be necessary. Treatment may be costly, but preservation of an existing resource will provide the municipality with a feasibility for making long-term water supply decisions. General recommendations for ground water exploration and development, discussed for the Upper Blackstone towns, also apply to Lincoln. These are especially important because there is opportunity now to protect an adequate ground water supply for even the long-range needs of the municipality. Therefore, the Study recommends:

23. Expand and treat ground water supplies in Lincoln. Lincoln should expand and treat its ground water supply for the purpose of providing adequate aquifer protection and resource development to meet long-range needs.

Table 4.5 lists the existing yields and projected 1990 demands for municipalities in the Woonasquatucket-Moshassuck River basin as well as the proposed additional sources of supply for these municipalities.

TABLE 4.5 SUMMARY OF 1990 WATER SUPPLY: WOONASQUATUCKET-MOSHASSUCK RIVER BASINS

	Existing Systems (1970)		1990 Average Demand mgd	1990 Design Demand** (mgd)	Proposed Additional Sources of Supply
Municipality	Source	Safe Yield* (mgd)			
Lincoln	Wells	5.5	3.39	6.44	Treated ground water
North Providence	Providence Water Supply Board	2.1	4.67	Same	Providence Water Supply Board
Providence	Scituate Reservoir	72.0	33.81	Same	Big River Reservoir
Smithfield	Providence Water Supply Board	0.9	2.10	Same	Providence Water Supply Board

* Ground water yield is reported as pumping capacity of system.
** Systems relying primarily on ground water sources must supply maximum day demands.

CHAPTER 5 WATER QUALITY

Because the Blackstone, Ten Mile, Woonasquatucket-Moshassuck river basin planning area is composed of three major basins in Massachusetts and Rhode Island, their water quality situations will be discussed separately. Table 5.1 illustrates the planning area's sewer systems, the population they serve, their degree of treatment, and the waters which receive their discharges.

THE SITUATION

Blackstone River Basin

Today the Blackstone River is grossly polluted, and unfit for most recreational uses although it has some scenic stretches. Water quality problems in the basin are the result of municipal and industrial wastewater discharges, combined sewer overflows, and non-point pollution problems such as landfill leachate, septic tank/leaching field effluents, and to some extent, urban runoff.

The sheer volume of wastewater discharged through combined sewers and the overloaded Worcester secondary treatment plant far outweighs any other waste input along the river, and therefore much of the opportunity for water quality improvement rests with the Upper Blackstone Water Pollution Abatement District. This district will have responsibility for treating the wastewater of Worcester, Auburn, part of Leicester, Paxton, Holden, Rutland, West Boylston, Boylston, and a portion of Shrewsbury. The facility to do this is now under construction at the site of the existing Worcester treatment plant with provisions for advanced treatment by 1983. Until this date, the large initial load, coupled with numerous smaller municipal and industrial discharges from downstream towns, will result in water quality below proposed state classifications.

Proposed water quality classifications recognize the inability of the relatively small Blackstone River to assimilate wastewaters discharged in Worcester. For about six to nine miles below Worcester, a classification of C-1 (unsuitable for contact recreation but with good aesthetics) has been proposed. Classifications of Class C and SC are proposed for the remainder of the Blackstone River. These segments would then be suitable for boating, secondary water contact, recreation, and indigenous fish habitat. A recommendation for realizing the full recreational potential of the River – the Blackstone River People's Public Park – is fully described in *Chapter 6.*

TABLE 5.1 SEWER SERVICE: BLACKSTONE AND VICINITY PLANNING AREA

Sewer System	1970 Population Served	Degree of Treatment	Receiving Waters
Worcester	170,000	Secondary[a]	Blackstone River
Millbury	2,200[b]	Secondary	Blackstone River
Upton	300	Secondary	West River
Northbridge	7,500	Secondary	Blackstone River
Hopedale	3,200	Secondary	Mill River
Douglas	1,240[c]	Secondary[a]	Mumford River
Burrillville	9,680	None	Branch River
Woonsocket	44,910	Primary	Blackstone River
Blackstone Valley Sewer District			
Cumberland	3,400	Secondary	Seekonk River
Lincoln	2,990	Secondary	Seekonk River
Central Falls	18,716	Secondary	Seekonk River
Pawtucket	76,984	Secondary	Seekonk River
East Providence	34,000	Secondary	Providence River
Providence	179,213	Secondary	Providence River
North Attleborough	11,200	Secondary	Ten Mile River
Attleboro	30,000	Secondary	Ten Mile River

[a] under construction
[b] design capacity for 1975
[c] design capacity for 1976

Overall, the Quinsigamond River is meeting its Class B standards (suitable for contact recreation). The Mumford River, above Douglas, is also meeting Class B standards.

Effluents from industrial discharges (Hayward-Schuster and Emil Bernat) and untreated Uxbridge sewage significantly degrade water quality below Douglas. The West River, which receives secondary treated effluent (advanced treatment in summer months) from Upton's facility, was at, or only slightly below, Class B standards. All but three miles of the Mill River below the Hopedale treatment plant are meeting Class B standards. However, residual nutrients from the facility's discharge result in aquatic plant growth in Harris Pond, in Woonsocket, Rhode Island.

In Rhode Island, the Branch and the Pascoag Rivers have existing segments of Class D quality with proposed C classifications. Other areas are at, or slightly below, B and C goals. The problem areas result from private sewer discharges and industrial discharges.

Ten Mile River Basin

The Ten Mile River originates in Plainville, Massachusetts, and flows in a generally southerly direction to the Seekonk River in East Providence, Rhode Island, a river mile distance of approximately 22 miles.

Water quality in this basin is determined by two classes of discharges. Organic dischargers include municipalities and textile and chemical industries. Inorganic dischargers include jewelry or metal finishing industries. As a result of these discharges, the greater part of the river is below water quality goals. Above the North Attleborough secondary wastewater treatment facility, the river receives wastes from several industries and malfunctioning septic systems in Plainville and North Attleborough. These sources of pollution result in water quality of Class C and B, with a Class B goal, suitable for any contact recreation, for the entire reach. Below the North Attleborough facility, the river has a proposed classification of C except for the last two miles, which have a Class B goal. Meeting these goals is an essential prerequisite for implementing the Ten Mile River Recreation Complex described in *Chapter 6*. Presently, due to the discharge of secondary treated wastewater from the municipal facilities serving North Attleborough and Attleboro, and industries in Attleboro and Seekonk, the river quality is generally Class U (unacceptable).

The two major tributaries to the Ten Mile River are the Bungay and Seven Mile Rivers. The Bungay originates in North Attleborough and flows south for five miles where it joins the Ten Mile in Attleboro. The entire Bungay River has a water quality goal of Class B, but at times is below that classification. A federal fish hatchery could be a partial cause of the pollution, and steps are being taken to correct this problem.

The Seven Mile River also originates in North Attleborough and flows south for seven miles to its confluence with the Ten Mile at the Massachusetts-Rhode Island border. The Seven Mile has water quality goals of Class A and B. However, agricultural runoff has precluded use as a water supply without treatment, despite the A classification.

Besides the two municipalities discharging to the Ten Mile, East Providence, Rhode Island has a treatment facility which provides secondary treatment with discharge to the Providence River (see Table 5.1).

Woonasquatucket — Moshassuck River Basin

The Woonasquatucket River begins in North Smithfield, Rhode Island and flows generally southeast through numerous impoundments before joining the Moshassuck in Providence and emptying into the Providence River. The upper basin is predominantly rural with scattered areas of development. The lower basin is highly urbanized, containing Johnston, North Providence, and Providence. The two sections are meeting water quality goals of Class B in the upper basin and Class C in the lower basin.

The Moshassuck has a similar urbanization pattern, originating in rural areas of Lincoln and ending at the confluence with the Woonasquatucket in Providence. The river is currently meeting Class C standards.

The Providence-Seekonk River borders planning area towns and is comprised of the most severely polluted waters in the planning area. Class SC classifications are proposed; however, water quality is presently SD and below.

Providence currently discharges over 50 mgd into the Providence River through a secondary treatment facility not operating at proper efficiency. North Providence, Providence, and Johnston are all served by this facility (see Table 5.1). More importantly, Providence is served by an extensive combined sewer system which, during rainfall or snow melt, tends to overload the treatment plant, thereby further reducing efficiency, as well as resulting in 56 direct discharges of combined stormwater and untreated wastewater to the Providence, Seekonk, Woonasquatucket, Moshassuck, and West Rivers. The Rhode Island Department of Health has determined that when one-half inch of rain is recorded in Providence in a 24-hour period, the shellfish areas in Upper Narragansett Bay must be closed for seven days. For a recording of one inch, the closure is effective for ten days. In the past, the total number of days the shellfish areas have been closed in one year has exceeded 200.

Thus, while the principal need in the basin is for combined sewer abatement, there is also a need for sewer service in

areas of Smithfield and Lincoln, and for extensive sewer system repair in North Providence.

THE SOLUTIONS

Preservation

There are high quality waters in the Blackstone, Ten Mile, Woonasquatucket-Moshassuck planning area. The environmental and aesthetic qualities of these waters must be protected. In addition, economic benefits will be achieved by precluding the need for some costly facilities-oriented restoration projects. For these reasons, and others outlined in *Chapter 5 of the Regional Report,* the SENE Study places high priority on preservation of the planning area's high quality waters. Preliminary steps have been instituted by Massachusetts and Rhode Island in their water quality standards through inclusion of anti-degradation policies. The SENE Study endorses these policies and makes the following recommendation:

1. **Carry out current state non-degradation policies. In Massachusetts, the Department of Environmental Quality Engineering should ensure that no new discharges will deteriorate the quality of stream water above the most upstream municipal discharges and Class SA and SB waters (shellfish harvest and swimmable-fishable salt water), with conditioned exceptions; (a) to allow new cooling water discharges if standards of the receiving waters are met; (b) to allow new municipal discharges if part of a comprehensive plan; and (c) to require existing discharges to cease and either connect to a municipal system or provide high degrees of treatment consistent with maintaining high quality waters.**

   In Rhode Island, the Department of Health should ensure that no new discharges will deteriorate the quality of Class A, B (drinkable, swimmable), SA and SB waters.

These statements recognize that there are certain waters which simply should not be subjected to wastewater discharges at any time regardless of degree of treatment. The reasons include the size and sensitive nature of the stream, general aesthetic considerations and development pressures, and resultant degradation which may accompany a discharge.

Restoration

Many pollution problems in the Blackstone, Ten Mile, Woonasquatucket-Moshassuck planning area include combined sewers and urban stormwater runoff, industrial discharges, and municipal discharges. Landfill leachate is also a moderate source of pollution in some parts of the planning area. These problems must be corrected by a program of restoration. Regulation and permitting of discharges, and construction of treatment facilities can be used to achieve proposed water quality goals.

Combined Sewers and Stormwater Runoff

Much of the City of Providence is served by combined storm and sanitary sewers. During dry weather periods, the wastewaters in these sewers are conveyed to the Providence Municipal Wastewater Treatment Plant. However, at times of heavy rainfall, the combined sewage and stormwater flows exceed the capacity of the system and result in overflows to the Woonasquatucket, Moshassuck, West, Seekonk, and Providence Rivers.

Based upon the severity of pollution, expected water uses, and the population affected, the Rhode Island Division of Water Supply and Pollution Control has determined that Providence's combined sewer problems are the number one priority in the state. Water quality restoration will enable more of upper Narragansett Bay to remain open to shellfishing and will improve overall aesthetics in the Providence River. Recently, Providence received an Environmental Protection Agency (EPA) planning grant to study the combined sewer problem. The study alone will take 18 months and will cost a total of $668,000, paid by EPA, Rhode Island, and Providence. Cost estimates for separation range from $90 million to $500 million, depending on the degree of separation provided. Regardless of the degree, the SENE Study believes that water quality analyses must be performed and a sampling program developed by Rhode Island and the EPA, to ensure that the improvements which are made in the combined sewer system will result in the opening of shellfish areas in upper Narragansett Bay. Urban runoff from the densely populated core may still result in closures. If this is the case, treatment of combined sewer overflows rather than separation may be a more cost-effective means of restoring the affected areas. Other municipalities in the planning area with combined sewers and their related problems are Worcester, Pawtucket, and Central Falls. Specific recommendations for these municipalities may be found in the "Municipal Discharges" section of this chapter.

In general, the SENE Study recommendation is as follows:

2. **Emphasize treatment of combined sewer overflows. The U. S. Environmental Protection Agency, the Massachusetts Department of Environmental Quality Engineering and the Rhode Island Department of Health should emphasize the treatment of combined sewer overflows, especially where the receiving waters have a high value for swimming and shellfishing. These agencies should discourage separation of combined**

sewers unless separation can be demonstrated to be more cost-effective than other methods.

It is especially important that the urban stormwater runoff problem be corrected in the developed and developing sections of this planning area. Wet-weather sampling, discussed in *Chapter 5 of the Regional Report (Water Quality)* can provide a rational basis for a badly-needed non-point source abatement program. The SENE Study recommends that the proper agencies:

3. **Begin stormwater and wet-weather stream sampling. In areas of high urban stormwater runoff, the Massachusetts Department of Environmental Quality Engineering and the Rhode Island Department of Health should begin a major year-round stormwater and wet-weather stream sampling program.**

Sewer separation may be implemented for some of the municipalities in this planning area, such as Worcester. Unlike treatment techniques, combined sewer separation will not improve the quality of urban runoff reaching a water body. Therefore, water quality goals may never be reached in these areas unless the runoff problem is solved.

Industrial Discharges

Industrial discharges have been a major source of pollution in the Blackstone, Ten Mile, and Woonasquatucket-Moshassuck planning area. However, industrial pollution is being diminished by the National Pollutant Discharge Elimination System of industrial permits, administered by the EPA under the Federal Water Pollution Control Act Amendments of 1972.

All but three industries in the Blackstone basin will connect to eight municipal treatment plants when the plants are completed. Of the three remaining industries, one will provide treatment and subsurface disposal, one will provide advanced treatment, and one may do either.

Industrial discharges along the Ten Mile River will provide best practicable treatment technology by July 1, 1977, as required under the Federal Water Pollution Control Act Amendments of 1972, unless pre-treatment and connection to a municipal system are feasible. Currently there are 31 firms providing treatment equivalent to secondary, eight former discharges are connected to the municipal systems, and two former dischargers are recycling wastes. For certain other firms, recycling may be desirable and should be encouraged. Four remaining discharges are to connect to municipal systems.

In the Woonasquatucket-Moshassuck basin, all industrial discharges of oxygen-demanding wastewaters will connect to expanded treatment facilities. The only other discharges to the waters of this basin will be that of an advanced treatment facility and two cooling water discharges.

The SENE Study makes the following recommendation:

4. **Continue current industrial permits program. The U. S. Environmental Protection Agency, the Massachusetts Department of Environmental Quality Engineering, and the Rhode Island Department of Health should continue the current industrial permits programs, which are part of the National Pollutant Discharge Elimination system.**

Municipal Discharges

Presently, municipal discharges are another major source of pollution in this planning area. The following discussion presents a facilities-oriented approach to upgrading the quality of the area's waters. Each of the three major basins will be considered separately.

Blackstone River Basin. As part of the continuing planning process required of each state by the Federal Water Pollution Control Act Amendments of 1972, the Massachusetts Division of Water Pollution Control has developed allowable waste loads and target dates for wastewater dischargers in the Blackstone basin. This *basin plan* gives the strategy necessary to achieve the desired water quality standards. Based upon the available information, the SENE Study endorses the proposals presented in that basin plan. When implemented, it will result in eight direct municipal discharges to the waters of the basin (seven requiring advanced treatment and one requiring secondary treatment). The actions to be taken by the municipalities in the *Massachusetts* portion of the basin are summarized in the following list. Recommendations 5, 6, 11, and 13 are of high priority.

5. **Construct advanced treatment plant for Upper Blackstone municipalities. The Upper Blackstone Water Pollution Abatement District will have an advanced wastewater treatment facility in operation by 1983. Secondary treatment works are now under construction. Member communities are Worcester and Auburn. Other eligible communities are Leicester, Paxton, Holden, Rutland, West Boylston, Boylston, and Shrewsbury. (Portions of Shrewsbury are served by its own plant.)**

6. **Complete separation of combined sewers in Worcester by 1980. In Worcester, complete separation of combined sewers, in conjunction with urban renewal projects, will be finished by 1980. Presently, many miles of Worcester's combined sewers have been separated. This is one area where separation can be accomplished and where treatment techniques alone will not**

yield appreciable water quality benefits.

7. **Upgrade treatment plant to advanced to serve Millbury and Sutton.** Millbury, which has a new secondary treatment plant, will provide advanced treatment to serve Millbury and portions of Sutton. Discharge will be to the Blackstone River.

8. **Construct advanced treatment plant in Grafton.** Grafton will construct an advanced treatment facility with discharge to the Blackstone River.

9. **Maintain advanced treatment plant in Northbridge.** Northbridge provides advanced treatment with discharge to the Blackstone River.

10. **Provide advanced treatment in Upton after 1985.** Upton, which provides secondary treatment and sand filtration, will be able to rely on its existing facilities until 1985. At that time it will provide advanced treatment with discharge to the West River.

11. **Provide advanced treatment in Hopedale by 1978.** Hopedale will provide advanced wastewater treatment. Its existing secondary treatment will be replaced, and discharge will be to the Mill River by 1978.

12. **Construct advanced treatment plant in Uxbridge by 1978.** Uxbridge will construct an advanced treatment facility with discharge to the Blackstone River by 1978. Mendon may eventually connect at some future date.

13. **Construct secondary treatment plant in Douglas.** Douglas is constructing a secondary treatment facility with discharge to the Mumford River. A portion of Sutton may eventually be served.

14. **Connect Blackstone to Woonsocket's treatment plant by 1976.** Blackstone will connect to Woonsocket, Rhode Island's treatment facility, by a target date of 1976. Millville will also be served by that facility at some later date.

Alternatives which have been considered mainly involved alternate treatment plant configurations. The recommendations minimize the number of discharges by stressing regional systems. Currently, land disposal has not been found to be feasible in this basin, due to the apparent lack of suitable sites. However, more detailed engineering investigations are required before federal construction grants are given. These investigations must look into land disposal possibilities. The programs should attain water quality goals explained previously. Estimated costs for planning area cities and towns are listed below:

Worcester	$24,000,000	Uxbridge	$3,400,000
Shrewsbury	2,000,000	Sutton	800,000
Auburn	5,000,000	Douglas	3,600,000
Millbury	500,000	Hopedale	1,500,000
Grafton	6,000,000	Mendon	450,000
Upton	300,000	Millville	3,000,000
Northbridge	1,500,000	Blackstone	1,400,000

These costs are only preliminary figures based on estimated flows, and represent costs of major interceptors and treatment facilities.

In the Rhode Island section of the Blackstone basin, preliminary proposals have been developed by town consultants and state agencies (Rhode Island Statewide Planning Program and the Department of Health). Based on those preliminary alternatives, the SENE Study recommends the following facilities plan for implementation and inclusion in the *Rhode Island* portion of the basin plan.

15. **Provide secondary treatment in Woonsocket and other towns by mid-1977.** Woonsocket will provide secondary treatment with discharge to the Blackstone River by the end of 1976. The facility will serve Woonsocket, and portions of North Smithfield (by mid-1977) and Cumberland, Rhode Island and Blackstone (in 1976), Millville, and southern Bellingham, Massachusetts.

16. **Construct secondary treatment plant in Burrillville by mid-1977.** Burrillville will construct a secondary treatment facility by mid-1977 to serve that town and northern Glocester with discharge to the Branch River.

17. **Maintain secondary treatment plant for Blackstone Valley Sewer District.** The Blackstone Valley Sewer District will maintain existing secondary treatment facility with discharge to the Seekonk River. The facility will serve Pawtucket, Central Falls, and Lincoln, and portions of Cumberland, Smithfield, and East Providence.

18. **Provide partial separation of combined sewer overflows in Central**

Falls and Pawtucket. Central Falls and Pawtucket will provide partial separation of combined sewer overflows to eliminate the largest, most frequent overflows.

These facilities will maintain water quality at Class C levels, suitable for recreational boating and fishing, and will upgrade the Branch River to Class C levels through the elimination of industrial and small individual wastewater discharges. It appears that the only potential for land disposal exists for the Burrillville facility. This must be investigated before a federal construction grant can be given. This plan results in fewer discharges than others considered because of the regional approaches taken. In addition, it is $2 to $7 million cheaper than other feasible alternatives.

Provision of advanced treatment capabilities should be made at the Burrillville facility if it can be shown, through water quality monitoring and modelling, that Class B waters can be attained throughout the Branch River. This would increase construction costs by about $1 million. Preliminary costs of each facility are: Woonsocket – $27,500,000; Burrillville – $9,225,000; North Smithfield – $6,000,000; Blackstone Valley Sewer District – no further construction costs needed. Sewer system improvements to minimize infiltration into the Pawtucket and Central Falls systems are needed to ensure no further expansion at the District's plant.

Ten Mile River Basin. The Massachusetts Division of Water Pollution Control has developed a preliminary basin plan for the Massachusetts section of the Ten Mile basin as required by the Federal Water Pollution Control Act Amendments of 1972. The major points of the *Massachusetts* portion of the basin plan as endorsed by the SENE Study are:

19. **Expand and upgrade North Attleborough plant to advanced by 1977. The North Attleborough facility will be expanded and upgraded to advanced treatment by 1977 with discharge to the Ten Mile River. Plainville will also be served by this facility.**

20. **Expand and upgrade Attleboro plant to advanced by 1979. The Attleboro facility will be expanded and upgraded to advanced treatment by 1979 with discharge to the Ten Mile River. Portions of Seekonk will also be served by this facility.**

For the *Rhode Island* section of this basin, the following facility, proposed by the Rhode Island Statewide Planning Program and the Department of Health, is under construction:

21. **Provide secondary treatment to Barrington from East Providence plant. The East Providence wastewater treatment facility will continue to provide secondary treatment with discharge to the Providence River. Barrington will be served by this facility in two phases by mid-1977.**

These efforts will result in attainment of the water quality standards adopted for the waters of the planning area, and will eliminate problems associated with poorly operating septic systems. The regional approach is stressed to eliminate discharges and to lower construction costs while achieving efficiently run facilities. Land disposal does not appear to be a viable alternative in this basin because of the lack of suitable sites as well as the amount of metals which would be in any treated effluent. Anticipated construction costs of major interceptors and facilities for each planning area community are: Plainville – $1,400,000; North Attleborough – $10,000,000; Attleboro – $15,000,000; Seekonk – $1,000,000; East Providence – $8,000,000; Barrington – $14,100,000.

Woonasquatucket-Moshassuck Basin. Engineering consultants for the municipalities in the Woonasquatucket-Moshassuck basin, along with the Rhode Island Statewide Planning Program and the Department of Health, have developed current proposals for municipal treatment facilities. The SENE Study endorses these proposals, which have been included in the state basin plan prepared by Rhode Island Statewide Planning in cooperation with the Department of Health. The proposals are:

22. **Construct advanced treatment plant in Smithfield. Smithfield will construct an advanced wastewater treatment facility with discharge to the Woonasquatucket River.**

23. **Expand sewer service in Lincoln. Lincoln will expand sewer service in the town with continued discharge to the Blackstone Valley Sewer District.**

24. **Continue service from Providence treatment facility to five municipalities. Providence secondary wastewater treatment facility will continue to serve Providence, North Providence, and Johnston, as well as providing service to portions of Cranston and Lincoln. Partial separation of combined sewers to eliminate the largest, most frequent overflows in Providence should be deferred until the current study on combined sewers (see above) is completed.**

Alternatives which would have resulted in more discharges were not recommended over this regional approach. The combination of North Providence sewer system repair and,

if undertaken, Providence combined sewer separation, could reduce average daily flow to the Providence plant by 40 percent, thus forestalling expansion at the plant for some time. Costs of the proposal are: Smithfield – $15,200,000; North Providence – $7,500,000; Providence – $90,000,000 to $500,000,000.

Landfill Leachate

If sanitary landfills are not properly sited, leachate percolating through the landfill to the water table can cause significant ground water pollution. Proper siting of solid waste disposal sites in accordance with sanitary landfill regulations should be sufficient to prevent future degradation of water resources. Where existing sites present problems, corrective measures should be taken to prevent further degradation of water resources. Towns in the planning area which have problems with surface drainage and leachate, and with the lowest portion of the fill in the water table, are: Millbury, Sutton, Woonsocket, Burrillville, and North Attleborough. Towns exhibiting the first two of the problems are: Northbridge, Seekonk, and Plainville. Cumberland's landfill has surface drainage problems only. The SENE Study recommendation is as follows:

25. Study and define the landfill leachate problem. The Massachusetts Department of Environmental Quality Engineering and the Rhode Island Department of Health should make further field investigations and studies to better define the extent and nature of water quality problems associated with existing and abandoned solid waste disposal sites, with a view to developing adequate perspectives and rational controls.

Septic Systems

Another threat to water quality is malfunctioning septic systems. These have resulted in the preceding proposals for sewer service and attendant treatment facilities. Rigid enforcement of existing regulations may preclude many of the problems of these systems. However, an in-depth look at the criteria for locating, siting, and designing individual subsurface disposal systems is also necessary since some aspects of existing regulations may still allow problems to develop. For example, high percolation rates coupled with the minimum allowable depth to ground water may result in bacterial contamination, nitrate build-up, or even phosphate build-up in that ground water. Also, allowing systems to be placed in fill material might invite clogging conditions at the fill-old ground interface.

Rhode Island has recently reviewed and updated regulations regarding individual subsurface disposal problems and believes them to be adequate. Massachusetts has contemplated this step. There is strong public support for the Massachusetts Department of Environmental Quality Engineering to review and update the existing regulations with particular attention to the allowable depth of subsurface systems to ground water and the maximum rate of percolation. The second concern is a function of porosity and slope and is important because rapidly flowing, non-purified septic wastewater can contaminate water supply. With proper enforcement, and by restricting the use of such systems to those lands suitable for septic tanks, individual disposal systems should continue to be useful for an important portion of future residential development. Without such precautions, the cumulative failure of individual systems will intensify pressure for sewer extensions and new treatment works. The result will be new concentrations of effluent in high quality streams, loss of in-basin ground water resources, increased municipal service costs, and, inevitably, the increased density of development induced by sewer service.

Clean-up Campaigns

A final program is applicable, especially to the urbanized portions of the basins. Riverbank clean-up campaigns, such as "Project ZAP" on the Blackstone and similar activities on the Ten Mile, encourage public responses to pollution control efforts. Worcester has had several effective annual spring clean-ups on the shores of Lake Quinsigamond. The Grafton Conservation Committee has also successfully monitored abuses to water quality. Projects such as these should be encouraged in order to gain further benefits of water quality control projects.

CHAPTER 6 OUTDOOR RECREATION

Next to the Boston Metropolitan planning area, the Blackstone-Ten Mile-Woonasquatucket-Moshassuck has the fastest growing recreation demands in SENE. Six percent of the extensive forests and fresh water resources sandwiched between the Providence and Worcester metropolitan areas is available to satisfy these rapidly growing demands. New acquisitions, access, and additional facilities have to be developed.

Because there is no coast line in the planning area, swimming and boating are two activities which have large deficiencies. Except for a few fresh water beaches considered in the General Recreation section, demands for these activities will have to continue to be satisfied in other parts of the SENE region. Therefore the *Narragansett Bay Planning Area Report* recommends the continuation of the Rhode Island Department of Natural Resource's program to provide public transportation to beaches nearby.

It is possible that a portion of the Seekonk River could supply a major portion of the region's recreational boating demands. Recommendation 7 *in Chapter 6 of the Regional Report* suggests that the Corps of Engineers, together with state and municipal officials and private interests, investigate this possibility within the context of the region's boating needs and conditions along the Seekonk River, as measured against alternative locations.

GENERAL

OUTDOOR RECREATION

The Situation

The existing publicly owned recreational facilities will not be able to meet 1990 demands. Of the recreational activities considered, swimming beaches and campsites will continue to be the two largest deficiencies in the planning area. The Bureau of Outdoor Recreation (BOR) estimates that existing publicly accessible fresh water beaches could meet 14 percent of the 1990 demands, and that existing camping facilities could supply a fifth of the 1990 demands. Furthermore, existing picnic facilities could meet about a quarter of the 1990 demands. The existing publicly accessible natural areas could meet nearly 42 percent of the 1990 demands for nature study, photography, and other demands for extensive outdoor recreation.

Chapter 6 of the Regional Report explains that private recreational enterprise is important for developing picnicking and campground facilities. To encourage these private developments in environmentally sensitive ways, the Study has recommended a state recreational advisory committee composed of representatives from Massachusetts Department of Commerce and Development, Rhode Island Department of Economic Development, and both states' natural resource management agencies, in addition to municipal and private representatives.

There are several large parcels of land and water resources in the planning area which could be acquired and developed. More noteworthy, however, are numerous opportunities for means of satisfying recreational demands which require smaller sums than new acquisition and development.

Another special problem for the Blackstone-Ten Mile-Woonasquatucket-Moshassuck planning area involves the inadequacy of day parks and playgrounds within Providence, Pawtucket, Cranston, and East Providence to meet the demands of these densely populated centers. In Pawtucket and Providence, the city-wide major park systems make up 70 percent of the total public recreation and open space land. In Pawtucket, the city-wide system consists of the state's Ten Mile River Reservation and the city's Slater Memorial Park. The former is not developed for public use and the latter contains major portions not developed for public use. The intermediate cities of Cranston and East Providence have a substantially better distribution of total recreation acreage. Inspection of resources in these cities showed many local and city-wide recreation areas not yet developed, or underdeveloped, or, in some cases, not easily accessible to the major concentration of population. The effectiveness of a seemingly adequate resource base is therefore somewhat reduced.

The Solutions

The *Regional Report* describes two options for satisfying camping and picnicking needs, and six options for satisfying extensive outdoor recreation needs. The Regional Report also describes economic, environmental, and social implications of each option. The following recommendations for supplying the Blackstone's recreational needs have been based on an evaluation of those options and their implications.

Chapter 6 of the Regional Report explains that people in most parts of the U. S. drink water from rivers used for navigation or wastewater disposal, or reservoirs used for timber production or recreation. Reservoirs in Rhode Island, however, and, to some extent, Massachusetts, are used for a single purpose, the production of drinking water. While there are no state statutes prohibiting low-intensity

outdoor recreation on reservoir lands, there is a law holding local water authorities legally responsible for drinking water contamination. For their own protection, trespassing on watershed lands is prohibited. However, recent information indicates that recreational use of reservoirs and related lands, particularly storage reservoirs, can have minimal impact on bacteria and virus counts, certainly within the range of best known treatment levels.

However, as water authorities in the City of Worcester have pointed out, the major limitations are costs resulting from the additional levels of treatment required and from the need for recreational management. Such authorities need additional funds and technical assistance before they can consider low-intensity activities even on storage reservoirs.

The recommendation in the *Regional Report,* therefore, suggests that in Rhode Island the Department of Health, Statewide Planning Program, and local water authorities, and in Massachusetts, the Departments of Environmental Management and Environmental Quality Engineering, and local water authorities should develop guidelines and regulations for low-intensity outdoor recreation on storage reservoir lands, only. Specifically, in the Blackstone planning area:

1. **Develop guidelines to plan for low-intensity recreation on storage reservoir lands. Local water authorities should use the above mentioned guidelines to determine the suitability of storage reservoir lands for low-intensity recreational use.**

In addition, there are several water supply reservoirs and other ponds in the planning area which towns – using Land and Water Conservation Funds and, in Massachusetts, Self-Help funds – could develop for recreational purposes:

2. **Acquire local access near four Rhode Island lakes. Lincoln and Smithfield should acquire public access to shoreline along Wenscott Reservoir; Smithfield should acquire Wolf Hill near Stillwater, Waterman, and Mountaindale Reservoirs.**

3. **Acquire statewide access along Crystal Pond in Douglas.**

The Rhode Island portion of Wallum Lake also has recreational potential, but the Study did not recommend acquisition of recreational access because currently it is used for water supply to Zambarano Hospital and there are possible health conflicts *(see Chapter 4).*

In Massachusetts, there is the potential to gain abandoned mill dams for public use with minimal financial investment. The Mill Acts, passed in the latter part of the 19th century, authorized private mill developers to seize lands important for the production of water power by eminent domain. The logic was that the production of power was in the public interest. The public rights to abandoned mill ponds – whether they are access rights, reversionary rights, first choice to gain water rights – have not yet been ascertained.

Mill ponds in the SENE region, particularly along the Blackstone River, provide important and valuable recreational, historical, and aesthetic opportunities. However, the extent to which they would satisfy future outdoor recreation demands is difficult to ascertain because the total acreage, quality, and legal status have not been inventoried.

If such an assessment of the abandoned mill ponds, for example, in the Blackstone area, proved them to be significant recreational resources, the public interest could be assured through new legislation passed by the General Assembly. To assure the safety and protection of mill ponds, the state should also develop a policy and program for restoring and maintaining mill dams.

The major reason for the gross recreational deficiencies in core cities deals with severe financial limitation. Under the current local tax structure, which relies heavily on real estate, and considering the existing austerity budget of core cities, it would appear that neither the rate of recreation budget nor the proportion of the city's total budget it comprises will improve significantly. With the urban land pressures, and thus land prices, as they are, this precludes substantial land acquisition programs to meet the city's needs. Planning and recreation officials in the towns surveyed perceived little ability for the city to significantly add to the recreation land resources by the conventional land acquisition program.

In light of this situation, it is necessary to look for solutions other than simple acquisition of land. The federal Bureau of Outdoor Recreation (BOR) suggests that other opportunities exist for increasing both the acreage and the efficiency of urban recreation lands. It is recommended that appropriate officials:

4. **Acquire inner city recreation opportunities in at least six municipalities. Worcester, Providence, East Providence, Pawtucket, Woonsocket, and Cranston should improve inner-city recreation opportunities by the following means:**

   - **Increase the availability of community school facilities.**
   - **Develop multiple use of highway corridors, public works lands, and parking areas.**
   - **Develop improved pedestrian access to existing urban parks by such means as overpasses across transportation corridors.**

- **Develop a major program of soliciting land and easement donations.**
- **Develop a formal review system of tax title lands by planning and recreation agencies.**
- **Develop adequate recreation and open space in urban renewal areas.**
- **Consider the feasibility of re-routing commuter oriented bus service to better serve recreation areas, especially major beaches.**

Trails Advisory Committees in both states advise the DNRs about the appropriate locations of, and uses for, trails. The BOR has identified a whole network of trails throughout SENE, part of which stretches into the Blackstone basin:

5. **Consider a trail system from Douglas to Providence. Trails Advisory Committees in both states should assess the possibilities of a trail system along an abandoned right-of-way from Wallum Lake in Douglas to Providence, and recommend appropriate kinds of uses and development to the R.I. Department of Natural Resources and Mass. Department of Environmental Management. Another possibility is a 16 mile trail along the Blackstone River and Canal, as suggested in the Central Massachusetts Regional Planning Commission Report of April, 1972. A connecting Hike-Bike Trail, proposed by the City of Worcester, should also be considered.**

Both states could expand existing recreation properties in the Blackstone basin and develop them for camping and picnicking through these actions:

6. **Enlarge Douglas State Forest, consolidate Upton State Forest, and provide support for the Towns. Massachusetts Department of Environmental Management should enlarge the Douglas State Forest and consolidate Upton State Forest holdings, which are presently scattered around Upton. The state should consider investigating means of compensating the additional strains on municipal services.**

7. **Expand Diamond Hill, Lincoln Woods, and Casimir Pulaski State Parks. The Rhode Island Department of Natural Resources should expand Diamond Hill State Park by acquiring about 500 acres around Pine Swamp; expand Lincoln Woods State Park to include the Marsh Hill and area northwest of Olney Pond, possibly part of the Moshassuck River, and the east side of Butterfly Pond; and expand the Casimir Pulaski State Park to include Sprague Hill and Elbow Neck.**

As the level of water quality in the three rivers improves, they will increasingly become the focus of rehabilitation. The SENE Study recommends these two actions:

8. **Create a Ten Mile River recreation complex. Pawtucket and East Providence should create a Ten Mile River recreation complex. The complex would include the Ten Mile River Reservation and an extension, Slater Park, some land south of Slater Park, and East Providence watershed lands. This would create a continuous park system of some 800 acres in an urban area. In addition, as proposed in the East Providence Recreation Plan, this could be extended along the Runnin's River and into nearly developed Hundred Acre Cove, providing a continuous recreation corridor of some ten miles in length, only minutes from the densely populated cities of Pawtucket, Central Falls, East Providence, and Providence.**

The Mayor's Office in the City of Attleboro has expressed a concern for continuing this recreation complex into the Massachusetts portion of the Ten Mile River basin. The SENE Study encourages Attleboro, Seekonk, and Plainville to plan recreational development along the Ten Mile River and join forces with adjacent towns in this effort.

9. **Create a Blackstone River Park. As recommended by the Blackstone People's Park Association, Rhode Island Departments of Natural Resources, Massachusetts Department of Environmental Management and local communities should acquire lands for a 51-mile Blackstone River Park.**

The wetlands along the Blackstone River in Central Falls-Cumberland (see recommendation 12 in the Regional Report) play an important role in the Blackstone River People's Public Park. This 300 acre area potentially could provide fishing, boating, camping, swimming, and picnicking to the most densely populated cities of Rhode Island. For the successful completion of

this portion of the Park, the state would have to repair the Pratt Dam flood gate. The SENE Study encourages the municipalities and R.I. DNR to work with the Association to fund the acquisition and development of this important natural, historical and recreational asset.

Plate 3 shows the location of Critical Environmental Areas, which, as explained in *Chapter 3,* have important roles in natural processes such as riverine and coastal flooding and erosion protection. They can also be used for varying degrees of recreation. Since protection and development of such resources is best coordinated at the local level, the SENE Study recommends:

10. **Use SENE Development Capabilities Maps for open space protection. Municipalities should plan Critical Environmental Areas identified on SENE Development Capabilities Map (Plate 3) for open space protection and greenbelt programs. Methods for protecting such resources without outright acquisition are described in *Chapter 3 of the Regional Report.***

Implications

In line with the preferences of Blackstone, Ten Mile, Woonasquatucket-Moshassuck workshop participants, most of these recommendations are aimed at increasing fresh water oriented recreation opportunities, and involve mostly state responsibilities. However, local action in acquiring and managing fresh water recreation resources such as mill ponds and Critical Environmental Areas is just as important for meeting urban recreational demands. Town owned recreation areas would not go very far in meeting the planning area's large recreation demands. Furthermore, intertown cooperation in developing recreational resources – supported by state funds – maximizes efficient use of open spaces.

The Bureau of Outdoor Recreation estimates the total costs of the actions listed above to range somewhere between $60 and $80 million, while they would supply annual recreation benefits estimated at $37 million. They would provide enough picnic facilities to meet about 46 percent of the 1990 picnicking needs; enough campgrounds to meet almost a fifth of the 1990 camping needs; enough fresh water beach acres to meet over a third of the 1990 needs for swimming; and enough natural area to meet 61 percent of the 1990 needs for hiking, nature study, and other extensive activities. Unmet needs for these recreational activities would have to be supplied from other parts of, or outside of, the SENE region.

WILDLIFE AND FRESH WATER FISHERIES

The Situation

Compared to other planning areas in Southeastern New England, the Blackstone, Ten Mile, Woonasquatucket-Moshassuck planning area has few outstanding fish and wildlife habitats. Insufficient and/or low quality habitat cannot support even existing demands. The U. S. Fish and Wildlife Service estimates that about 40 percent of publicly and privately owned land in the planning area (166,200 acres of forests and fields) is open to hunting. Of over 26,000 acres of inland marshes and wooded swamps, about 500 acres of inland wetlands are publicly owned and accessible for hunting. If these areas remain open and unchanged, they could support 10 percent of the 1990 hunting demand. Of the 158 (11,205 acres) fresh-water ponds, 10 acres and larger, within these basins, only 20 (3,265 acres) have guaranteed statewide public access. Of the 200 miles of stream, the amount in public ownership and open to fishing is negligible. If all of these waters had adequate public access and were under fisheries management, they could support an estimated 520,000 man-days of fishing, approximately 40 percent of the planning area's 1990 demand.

The Solutions

Chapter 6 of the Regional Report describes four options for satisfying the planning area's future demands for wildlife, six options for future fishing demands, and the implications of each. The following recommendations are based on an evaluation of those options.

Due to multiple benefits of wetlands for flood reduction and wildlife production, the Study has recommended protection of them to the maximum extent; this can be done without impairment to economic growth *(see Chapter 3 of the Regional Report).* In Massachusetts, the Wetlands Protection Act, and in Rhode Island, the Freshwater, Saltwater, and Intertidal Wetlands Protection Acts, give municipalities substantial authority in deciding restrictions on wetlands use, but often their efforts are frustrated by inadequate knowledge or expertise. In Massachusetts, the Soil Conservation Service has developed a program whereby communities can get technical information about wetlands (and other natural resources) through Conservation District Offices. In Rhode Island, the Department of Natural Resources could provide similar information. Because cumulatively, municipalities can protect significant amounts of wetlands through legislative channels, the Study encour-

ages their responsibilities with these recommendations:

11. **Use the Massachusetts Natural Resources Planning Program to enforce wetlands legislation.** **Massachusetts municipalities should use technical information provided by the Natural Resources Planning Program, administered through Conservation District Offices, to enforce the existing wetlands legislation.**

12. **Provide technical assistance to Rhode Island municipalities to enforce wetlands legislation.** **The Rhode Island Department of Natural Resources should provide additional technical and legal assistance to local officials to improve enforcement of existing wetlands legislation.**

Outright acquisition is the safest assurance that wildlife habitats will be protected. The state's responsibilities should be to purchase those areas of regional significance including wetlands along the Chartley Brook – Hemlock Swamp in Attleboro, Rehoboth, and Norton, and along the lower Blackstone River in Cumberland. *(Chapter 6, SENE Study Regional Report).* Hence, the following recommendation:

13. **Acquire the most significant wildlife habitats.** **Communities and/or private interests in Massachusetts and Rhode Island should acquire the most significant upland and wetland wildlife habitats which are not protected by scenic, conservation or agricultural easements. The list of significant wetlands for the Blackstone and Vicinity planning area is too lengthy for this report, but can be found in SENE Study Single-Purpose Inventory information available at NERBC. To accomplish this, Self-Help funds are available in Massachusetts; Green Acres funds formerly available for local conservation-recreation acquisitions and development in Rhode Island should be revitalized.**

Edges between forest, field, and wetland are often the most productive wildlife habitats. Some of the Study's major policies are the protection of prime agricultural lands, wetlands, unique natural areas (Category A and B Resources), and other critical lands. Actions to protect these resources – *described in Chapter 3 of the Regional Report* – have secondary benefits for the wildlife enthusiast or hunter because of the implications for wildlife productivity.

Productive fresh water fisheries persist in the planning area's ponds, lakes, and streams. The Massachusetts Division of Fisheries and Wildlife has an active program of streambank acquisition, and the Public Access Board is legally charged to acquire public access to "great ponds" (those natural ponds 20 acres and larger) for fishing, and those natural ponds ten acres and larger for other recreational purposes. Public water supply reservoirs, previously discussed in this chapter, are also productive fishery habitats. To ensure the availability of fresh water fisheries for future generations, the Study recommends:

14. **Include ponds ten acres and larger for fishing in Massachusetts Great Ponds legislation.** **The Massachusetts Legislature should change the existing Great Ponds Act to designate ponds ten acres and larger "great ponds" for fishing.**

15. **Acquire access to ponds with good potential for fisheries production.** **The states should acquire access to ponds potentially productive for fishery resources:**

    - **In Massachusetts, the Department of Fisheries, Wildlife, and Recreational Vehicles should evaluate 26 ponds ten acres or larger of "good or best potential" (this lengthy list is identified in SENE Study Single-Purpose Inventories available from NERBC) and acquire public access to the most favorable.**

    - **In Rhode Island, the Department of Natural Resources should purchase access to ponds with good potential for fisheries production. There are 53 most important ponds, and the names can be found in SENE Study Single-Purpose Inventories.**

The Rhode Island Division of Fish and Wildlife is actively acquiring access points to fresh water resources, and developing boat ramps and landings where appropriate. The Study recommends they also consider the following action:

16. **Acquire access to streams with good potential for fisheries production.** **Agencies responsible for fisheries and wildlife in both states should acquire access to the potentially most productive fishing streams in the Blackstone and Vicinity planning area.**

    - **In Massachusetts SENE Study Single-Purpose Inventory has identified three with high fishery potential: Muddy**

Brook, Mill River in Mendon; West River, Blackstone River in Uxbridge; Center Brook, West River in Upton.

- **In Rhode Island, SENE Single-Purpose Inventory information has identified 11 with high potential: Abbot Run, Cumberland; Peters River, Woonsocket; Mill River, Woonsocket; Chepachet River, Burrillville; Pascoag River, Burrillville; Clear River, Burrillville; Nipmuc River, Burrillville; Ten Mile River, Seekonk; Seven Mile River, Pawtucket; Woonasquatucket River, Providence; and the Moshassuck River.**

Implications

Management of Category A and B lands would greatly improve the quality and productivity of these important wildlife habitats. Under management, these lands could support approximately 32 percent of the projected 1990 demands for hunting. An option of acquiring public access to all good wildlife habitat was not recommended: first, because of the expense involved; second, because hunting is prohibited in several towns; and, third, because public preferences expressed at the Blackstone, Ten Mile, Woonasquatucket-Moshassuck public workshop did not support the idea of public access to privately-owned land for hunting.

RECREATIONAL BOATING

Recreational boating in the tidal portions of the planning area is covered in the *Narragansett Bay Planning Area Report.*

CHAPTER 7 MARINE MANAGEMENT

There are few marine related issues in the Blackstone and Vicinity planning area. The Port of Providence, technically within this planning area, is covered in the Narragansett Bay Planning Area Report. Additional information from a wider perspective can be found in the SENE *Regional Report chapter on Marine Management.* That chapter covers, in specific fashion, sections on offshore fisheries, shellfish and aquaculture, port development, dredged materials disposal, offshore sand and gravel, and urban waterfronts.

Additional marine-related topics, such as recreational boating, beach swimming, coastal access, and salt water sportfishing can be found in the recreational section of the *Narragansett Bay Report, or Chapter 6 in the Regional Report.* Similarly, discussions on power plant siting, including coastal sites, and regional petroleum needs, including coastal implications for tank farms, are to be found in *Chapter 9, Locating Key Facilities in the Regional Report.*

URBAN WATERFRONTS

The Situation

Urban waterfront issues in major coastal and riverfront cities in the region have been discussed in a separate special report prepared for the SENE Study – the *Urban Waters Special Study.* Three Blackstone and Vicinity planning area cities are included in the report – Pawtucket, Woonsocket, and Attleboro. Two other cities, Providence and East Providence, are discussed in the *Narragansett Bay Planning Area Report.*

New England's waterfront cities were largely responsible for the area's rapid economic growth and development in the eighteenth and nineteenth centuries. As noted in New York's "Waterfront Workshop" conducted by the City's Planning Commission in 1974:

> "Time and technology have left stranded many once-busy segments of the waterfront. Brickyards, stoneyards, lumberyards, and coal terminals have either gone out of business or moved elsewhere. Containerization has shifted the volume of shipping business, and airlines and cruises have transformed passenger ship piers.
>
> "These changes have opened up the waterfront's potential, although in a double-edged fashion: because one type of development usually precludes all other alternatives, proposals may generate counter-proposals. A housing plan is met with the suggestion that a park would be preferable, a plan to site industry may arouse environmentalists, a plan to turn over an idle pier for recreation may be attacked as a blow at shipping. Almost everyone agrees that the shoreline is too valuable to be allowed to lie fallow, but agreement on a specific plan may be difficult to obtain. This is one of many contradictions enshrouding the waterfront."

In order to recapture the vitality which lies just beneath the surface of decay and neglect, a few institutional and administrative changes are needed, backed by public awareness. Several cities and towns have initiated or carried out sound programs for waterfront development or renewal, although their success has often occurred in spite of, rather than because of, current institutional and public policy.

The Blackstone River has been a major source of power to the industries located along it. Pawtucket, whose mills were powered by water, was the birthplace of the American cotton industry at the Slater Mill. Manufacturing is still the primary employer, with the textile industry accounting for one-third of the manufacturing jobs. While some industries still operate along the river, many of the industrial firms occupying textile mill buildings no longer have need for their waterfront location. Redevelopment has created some open spaces and parks along the immediate riverfront, including the historic preservation of the Slater and Wilkinson Mills. During the last decade, major redevelopment projects have focused on the amenities and recreation potential of the river, resulting in greater demand for improved water quality. Additional suggestions for use of these mill ponds are given in *Chapter 6.*

The original downtown urban renewal project set the stage for Pawtucket's continuing state and federally assisted urban renewal program. With a good track record in project implementation, the City has been successful in continuing to receive federal urban redevelopment assistance. Pawtucket is now one of the few cities in its fifth year of Neighborhood Development Program (NDP) assistance. Three of the NDP's include river frontage and will bring about the further redevelopment of the Blackstone and Seekonk riverfronts. As a basis for coordinating the NDP planning along the riverfront, a report was prepared by that program which sets forth the general guidelines for riverfront planning and design and then evaluates alternative development proposals leading to specific recommendations for renewal sites.

The Blackstone River provided the basis for Woonsocket's growth and development. Originally a number of separate mill villages along the River, Woonsocket has now developed into a fairly dense city with the areas between the mill villages filling in with residential and other supporting uses. Many of the mills, some of historic and architectural significance, have been torn down and replaced with other uses.

The Blackstone River no longer serves the strong role it did in Woonsocket's past.

Yet several large mill complexes remain and are in industrial use, some being of historic and architectural significance. As in Pawtucket, textile manufacturing is the largest manufacturing employer, accounting for approximately one-fourth of the manufacturing jobs.

Severe damages caused by the August 1955 flood, which inundated the entire downtown area, led to major flood control works built by the Corps of Engineers. The dikes, flood walls, and channelization have achieved their objective of flood protection, but have also made difficult the kinds of renewal and recreational development which capitalize on views of the river and provide riverfront parks. While such conditions do not exclude the possibility of renewal and recreational development, in some cases, particularly Woonsocket's, they may complicate the costs and design of such redevelopments. This result lends further support to multi-objective planning for flood-control projects.

The City has embarked upon a plan to build a new downtown in the Social Flatlands area, to rehabilitate adjacent sections of downtown, and to eventually tear down the remaining portions of the old commercial center and replace that area with housing or some other use. Such projects will require the major share of the City's limited resources for some time. Much of the riverfront is in public ownership, and proposals for recreation use have been put forth, including means for designing over and around the dikes. However, given the major cost of creating attractive and accessible riverfront recreation due to the barriers created by the massive flood control devices, most of these projects are expected to be postponed until adequate funding can be made available. The City is redeveloping Social Pond into an attractively landscaped, waterfront-type, public open space.

Attleboro, Massachusetts is located along the narrow Ten Mile River. Attleboro's growth was once dependent upon its rivers, with its oldest areas built up along the Ten Mile. Today jewelry and textile industries still utilize the river for production processes and waste disposal. In the City center the river passes through heavily built areas where buildings are immediately adjacent to the river, although parking and vacant lots also abut the river. Neither the City's topography nor its street circulation system provide much view or access to the river.

New development in Attleboro bears little relation to the river. Attleboro's industrial base is diversifying into areas such as electronics, and the new industry is no longer being constructed along the river. Other new development proposals, as expressed in the City's Comprehensive Plan, also are not related to the river. Due to the highly polluted nature of the river, proposals for recreation, downtown renewal, or new housing make no reference to utilizing the river as an amenity or using the riverfront as a potential development site. Yet, water quality and flooding are important issues, and these problems are being addressed by the Ten Mile Task Force, a multi-jurisdictional organization seeking to improve the quality and usability of the river.

The Solutions

By integrating master planning and development control functions in urban waterfront areas, local governments can focus public interest and concern on relevant development issues and establish administrative framework at the local level. In light of the previously discussed options, the following actions are recommended in order to enhance the reuse of urban waterfronts in a rational and balanced manner.

1. **Coordinate local waterfront planning and development. Municipalities should prepare or plan for the long-term use or reuse of waterfront areas. In undertaking such activities, towns should give special consideration to factors such as the protection of flood prone areas, the preservation and enhancement of historic sites and buildings, the provision of public access easements (both physical and visual) in new development, building height, and so forth, consistent with Critical Environmental Areas as specified in** *Chapter 3, Guiding Growth.*

While primary responsibility for initiating and carrying out land use decisions should remain at the local level, the state should perform the following critical functions:

2. **Provide guidance and set criteria at the state level for priority waterfront uses. Massachusetts and Rhode Island, through their Coastal Zone Management Programs or state land use planning programs, should develop urban waterfront planning and management guidelines, and criteria for deciding priorities for uses to be incorporated into local waterfront master plans. Priorities should be established for water-dependent uses, water related uses, complementary uses, and low-priority uses.**

3. **Review and coordinate waterfront use. Massachusetts, through its regional planning agencies, and Rhode Island, through its Statewide Planning Program and Department of Community Affairs, should exercise their powers to review and revise major waterfront development proposals of more than local concern.**

At the federal level:

4. **Provide federal funding support for state and local waterfront development plans. The U. S. Congress and the Office of Management and Budget should approve adequate federal funding for state coastal zone planning programs and for other planning programs which enhance waterfront redevelopment.**

Implementation of coordinated local and state approaches to waterfront use should help to minimize fragmentation of decisions in waterfront areas while recognizing the appropriate roles of the different levels of government. Agreement on appropriate guidelines and priorities should help to reduce conflicts between uses and increase the chances for a variety of uses along urban waterfronts.

More sensitive and sensible use of waterfronts will reinforce use of existing infrastructure and help to reutilize urban areas which have considerable economic and aesthetic potential.

CHAPTER 8 FLOODING AND EROSION

Inland flooding problems along the Blackstone, Ten Mile, Woonasquatucket, and Moshassuck Rivers stem from increased urbanization, encroachment of the flood plains, loss of inland wetlands, lack of periodic channel and mill dam maintenance, and inadequate channel capacity. Riverine flood problems have generally increased in most communities, and particularly in Cumberlar l, Rhode Island. In view of these trends, increased emphasis is needed on non-structural measures such as wetlands protection, flood plain zoning, and expanded flood warning services as tools to help prevent further increases in flood damages. Although inland wetland losses during the past 15 years have been moderate in the Massachusetts section of the planning area, significant wetland losses have occurred, in the northeastern section of Rhode Island, from housing developments and increased urbanization. In addition to development on the flood plains, recent highway construction has increased the potential for flood damage in areas where flood problems already existed.

In general, the Study's recommendations emphasize that both inland and coastal flood prone areas be protected from development by using non-structural solutions wherever possible, such as protection of wetlands and enforcement of strict development criteria. Only in areas having high concentration of development where options for relocation are limited should structural solutions be proposed to protect development from flooding. Recognition of the multiple values of wetlands – not just as natural flood retention areas, but for wildlife habitat, water supply, recreation, and landscape quality as well – further strengthens the importance of wetlands protection as a means for reducing flood damages.

The Situation

Inland Flooding

Blackstone River. The flood of record in the Blackstone basin was in August 1955, caused by Hurricane Diane. That storm has been rated as having an estimated frequency of occurrence in excess of once in 150 years. Other major storms were in March 1968 (but flood flows were less than half those of the 1955 storm), July 1938, and March 1936. The August 1955 storm caused unprecedented damages, with greatest losses in Worchester and Woonsocket, Damages for the Blackstone Basin were estimated at nearly $68 million.

Subsequent to the 1955 flooding, several flood control projects were constructed: the Worcester Diversion project which diverts flows from Leesville Pond in Auburn, near the Worcester line, to the Blackstone River in Millbury; the West Hill flood control reservoir in Uxbridge, a small local protection project in Blackstone, and the Upper and Lower Woonsocket local protection projects in Woonsocket. These projects would prevent an estimated $94 million in damages in a recurrence of the August 1955 record flood.

Along the Blackstone mainstem and on many of the tributaries, are numerous, independently controlled, privately owned dams. They are relatively old and were developed by industry to provide a source of power and process water for their operations. These dams do not play a coordinated role in flood control because they are not operated for flood control. Failure of any one of these small dams could result in minor increases in downstream flood heights, and contribute to damage to downstream dams. However, the ponds created by the dams have recreational potential described in *Chapter 6.*

Despite measures already taken to provide protection from damaging floods, additional damages can be expected to occur as development continues within the basin. A recurrence of the August 1955 record flood in the Blackstone basin would cause damages estimated at more than $30 million (now under review by the Corps of Engineers). These damages would likely center in Northbridge, Uxbridge, Millville, and Blackstone, Massachusetts, as well as Cumberland, Lincoln, Central Falls, and Pawtucket, Rhode Island.

Woonasquatucket-Moshassuck River Basins. The flood of record on the Woonasquatucket was the storm of February 1886, with a rate of flow four times higher than the March 1968 storm. Throughout much of the upper portion of the watershed are many small mill ponds and dams which do not necessarily provide benefit in terms of flood reduction. This is because the storage areas are not sufficiently large to provide effective floodwater storage, and because they are not operated according to a flood control management plan. In fact, the structural instability of these impoundments poses serious potential flood damage problems. Commercial centers and transportation corridors in the Woonasquatucket flood plains (Providence and North Providence) are subject to moderate flood damages. A recurrence of the river stages experienced during the March 1968 flood would result in damages of more than $3 million, occurring primarily in North Providence.

The March 1968 storm produced high flood flows in the Moshassuck watershed. No record of the 1886 flood is available for this watershed. Like the Woonasquatucket, Moshassuck flood plains are becoming increasingly urbanized, and channel capability reduced by accumulation of

debris, inadequate bridge and culvert openings, and unauthorized filling along streambanks. Recurrence of the 1968 flood would cause substantial damage (subject to additional field investigation), primarily in Saylesville (town of Lincoln), and have its greatest effect on existing industrial and commercial development.

Ten Mile River. The March 1968 flood is the recent flood of record, with damages centered at industrial areas in Attleboro and North Attleborough. Based on preliminary regional stream gauge analysis, this storm is rated as a 25- to 50-year frequency storm; the August 1955 storm was second only to the 1968 storm.

Preliminary estimates indicate that a recurrence of the March 1968 flood in the Ten Mile River Basin would cause major damages in Attleboro and North Attleborough exceeding $1,000,000. Approximately 15 commercial properties, 15 industries, over 100 residences, and at least 20 road and bridge locations would suffer damages. Average annual damages are estimated to be at least $210,000.

Inland Wetlands

High and medium development pressures in the Providence and Worcester urban areas, as well as their surrounding suburban areas can be expected to cause significant increases in urban runoff and flood plain development (if not adequately regulated) and result in even greater potential flood damage. Additional wetlands destruction, especially in the Ten Mile and Woonasquatucket-Moshassuck basins, will compound the problem. Wetlands in the planning area total about 26,600 acres, while the flood plain areas (100-year frequency storm) total about 39,700 acres.

Although all three river basins have become highly urbanized in some sections and extensive development has occurred in the flood plains, continuing emphasis is needed on preservation of the remaining inland wetlands for natural valley storage and other purposes, and on regulation of further development in the flood plains. While non-structural solutions do not prevent damage to existing flood prone structures, flood plain zoning and preservation of natural valley storage areas are essential to minimizing future flood losses.

Inland Erosion

In the Massachusetts portion of this planning area, erosion and sediment problems have been minor. Extensive "sediment" deposits in many of the stream-channels, in fact, include materials which have settled out from sewage discharges and urban runoff. In the Rhode Island portion of the planning area there are slightly more serious sediment and erosion problems, making the need for municipal sediment and erosion control ordinances more pressing in this area. In general, erosion problems in this planning area, now through 1990, are expected to center on agricultural cropland and lands undergoing urban development. Lands under forest cover, pastures, and developed urban areas have few erosion problems and produce almost no sediment in the planning area. Where erosion damages exist, they can be avoided for the most part through a sound urban-environmental forestry program to retain as much of the native vegetation as possible.

A study of approximately fifteen existing sand and gravel pits in this planning area indicates that approximately one-quarter of these operations are creating sediment problems. Techniques such as sediment pools, vegetative cover, and landclearing during periods of minimum rainfall could eliminate these problems.

Tidal Flooding and Coastal Erosion

The Providence coastal area includes portions of four municipalities – Cranston, Providence, East Providence, and Pawtucket – and encompasses the Providence River and its northeastern tidal areas, and the Seekonk River (the commonly known name for the tidal portion of the Blackstone River). The shoreline is highly developed and there are very few critical erosion areas that need protection or preservation. A large number of structures along the shoreline prevent erosion. Except for two small beaches in the southern part of East Providence, the shoreline along the Providence and Seekonk Rivers is generally rocky or is protected by bulkheading or rock revetment.

However, there are some flooding and erosion problems: tidal flooding of lands, and destruction of bluffs and shoreline protective works from hurricane tidal flood waves. Hurricanes are not uncommon to the area, and severe damages were experienced from the hurricanes of 1938 and 1954, particularly to the city of Providence. The Fox Point Hurricane Barrier was completed in 1966 at a cost of $15.8 million (including 30 percent local participation), and is expected to prevent future tidal flood damages, estimated at $59 million in a recurrence of a tidal flood having a magnitude equal to the August 1954 hurricane flood, and $78 million in a recurrence of the record tidal flood that accompanied the September 1938 hurricane (1975 estimates). It protects the commercial and industrial center of the city, extensive transportation facilities, public utilities, business establishments, and many residential homes. However, in recent years substantial industrial and commercial development has occurred in relatively low-lying areas immediately behind the Providence River waterfront, and at several locations along the Seekonk River.

In addition to the hurricanes, a large number of other storms occur in the area. These include extratropical storms and "northeasters". The planning area is relatively protected from the frequent winter northeasters (because of wind direction), but they can be stalled in the area for

several days and cause higher tides than normal over a longer period of time.

With the exception of the Fox Point Hurricane Barrier, there are no other federal or state coastal protection projects or beach projects in the planning area. However, a plan that would have provided a reduction in hurricane flood levels in the area was published by the Corps of Engineers in 1966. The report was an interim hurricane survey of the Narragansett Bay area, including the Mount Hope Bay area, in Rhode Island and Massachusetts. It provided for the construction of ungated rock barriers across the lower portions of each of the East and West Passages to Narragansett Bay, and one across the upper end of the Sakonnet River tidal arm, with supplemental dikes at low-lying land areas. The plan was designed to reduce the 1938 flood level by 7.7 feet at Providence and a proportional amount for hurricane tidal floods of different magnitudes. The overall project was estimated in 1966 to cost $90 million. The project was unfavorably received because of local concern that the barriers would be detrimental to navigation and the ecology of the Bay and because of a reluctance on the part of the two states to meet the funding share required by the plan. As part of the ongoing PNB study, the Corps of Engineers will investigate alternative plans of protection at specific damage areas.

Only a few tiny pockets of coastal wetlands remain in protected coves. There is one wetland of 4.5 acres in Providence and another south of Goose Point on the Seekonk River. These wetlands have high value for wildlife and open space; their value as buffers from storm damage has been severely reduced. Emphasis must be placed on preserving these few remaining coastal wetlands, which have been classified by the Study as "A" resources, having the lowest tolerance for development.

Ongoing Programs

There are a number of ongoing programs dealing with flood control and flood plain management in the planning area. Among these are: the National Flood Insurance Program of the Department of Housing and Urban Development; flood and storm forecasting and warning services of the National Weather Service; Section 205, of the 1948 Flood Control Act as amended, which authorizes the Corps of Engineers to prepare flood control studies and projects; and mapping services of the Corps of Engineers, Soil Conservation Service (in the U. S. Department of Agriculture), and the U. S. Geological Survey. In addition, the following three major programs are ongoing in the planning area.

PNB. The Pawcatuck River-Narragansett Bay Drainage Basins (PNB) Urban Study is an expansion of a level C study now in progress by the New England Division of the Corps of Engineers for flood control and allied purposes. The purpose of an urban study is to provide federal assistance in resolving regional water resource problems, and to develop alternative plans that may be selected by state and local officials as components of a comprehensive urban area plan. Study elements include urban flood control and flood plain management and estuarine flood protection, as well as municipal and industrial water supply, navigation, water related recreation, and conservation of fish and wildlife resources.

The Corps of Engineers is presently studying several structural flood damage reduction solutions as part of the ongoing PNB flood control study. Improvements under consideration in the Blackstone basin include a multi-purpose reservoir in Burrillville (Nipmuc Reservoir – flood control and water supply) that would reduce flood damage in Northbridge, Uxbridge, Millville, Blackstone, Cumberland, Lincoln, Central Falls, Pawtucket, Burrillville, and North Smithfield. Other improvements under consideration consist of local protection works in Uxbridge and Cumberland and channel modification work, including removal or replacement of dams, in Cumberland, Lincoln, Central Falls, and Pawtucket.

In the Woonasquatucket watershed, channel work may be required from Olneyville (in Providence) to the confluence of the Woonasquatucket with the Providence River, and also in some isolated reaches upstream. In the Moshassuck watershed, a multi-purpose reservoir at Lincoln (flood control and water supply) is under consideration and some channel work may be required in downstream reaches.

The PNB study will be coordinated with ongoing Public Law-566 studies by the U. S. Soil Conservation Service, particularly in the Ten Mile and Woonasquatucket-Moshassuck basins.

PL-566. Two investigations are presently underway in the planning area under authority of PL-566, the Watershed Protection and Flood Prevention Act.

The Soil Conservation Service (SCS) is studying the possibility of reconstructing a dam on the upper Woonasquatucket River (so that the reservoir could be used for recreational and floodwater storage purposes), and the possibility of constructing two tributary floodwater retention structures. In the Moshassuck watershed, SCS is considering construction of two small floodwater retention structures in the event that a multi-purpose reservoir, under consideration at Lincoln by the Corps of Engineers for floodwater and water supply storage purposes, is not possible.

Only preliminary planning has been completed on the studies concerning the Blackstone and Woonasquatucket-Moshassuck basins; however, more detailed planning has been completed for the Ten Mile basin. In the Ten Mile River basin, SCS is

studying the possibility of constructing the Bungay River flood control reservoir at an estimated 1974 cost of $600,000 and the Manchester Pond diversion at an estimated cost of $1.5 million. The two projects in the Ten Mile basin would control 65 to 85 percent of the contributing drainage area of the Ten Mile River and would reduce damages substantially.

It is estimated that average annual damages to existing development of $210,000 would be reduced by at least 80 percent. The occurrence of a flood event similar to that of March 1968 should cause no significant damages in Attleboro with the Bungay site structure and the Manchester Pond diversion in operation.

The Bungay project would have a minimum effect on water supply because the storage capacity would be low and flood flows would be released within 5 to 10 days after a storm. The proposed Manchester Pond diversion offers possible water supply augmentation. The existing reservoir capacity would be raised, and floodwaters would go through the same treatment as water in the existing reservoir. The Massachusetts Department of Environmental Quality Engineering must approve this project because of the questionable quality of stormwater flows. Because these projects would be part of an overall flood plain management and flood protection plan, further study would have to demonstrate the appropriateness of the plan before they can be authorized.

RC&D. The Soil Conservation Service (in the U. S. Department of Agriculture) is conducting two RC&D projects with a number of state and local sponsoring and cooperating agencies. The Pilgrim Area Resource Conservation and Development Program includes the Ten Mile watershed municipalities; the Rhode Island RC&D program covers all Rhode Island municipalities in the planning area. The plan for the project area is designed to set forth opportunities for economic growth resulting from the development, conservation, and utilization of the natural resources of the area. Up to 100 percent of technical and construction costs can be made available for flood prevention structures and land stabilization.

The Solutions

A number of options were considered for reducing flooding and erosion damages in both inland and tidal portions of the planning area. These alternative measures are more fully discussed in the *Regional Report, Chapter 8.*

Recommendations

A major result of the SENE Study has been the classification of the region's resources according to their capability. Critical Environmental Areas include inland and coastal wetlands and some have been classified as "A" resources, requiring the greatest degree of protection from development. Flood plains (to the 100-year flood frequency line) have been classified as "B" resources or management areas which have very limited tolerance for development, but with proper management are suitable for such compatible activities as agriculture or recreation.

In keeping with these resource classifications, it has been recommended that comprehensive flood plain management programs be developed which use non-structural solutions wherever possible. As discussed in the previous section, the ongoing PNB and PL-566 studies together cover this entire planning area, and the Pilgrim Area and Rhode Island RC&D projects also add local solutions for flood control, among other priorities.

As discussed more fully in *Chapter 8 of the Regional Report,* an important recent development is Section 73 of the Water Resources Development Act of 1974, which authorizes federal cost sharing for non-structural measures. Although implementation of Section 73 has presently been deferred by the Office of Management and Budget (OMB), application of the cost sharing authority can be an important factor in making non-structural solutions more competitive than they have been. Therefore, these programs – the PNB, PL-566, and RC&D programs – should include careful reconsideration of the extent to which non-structural solutions can be recommended to reduce future flood damages.

1. **Develop comprehensive flood plain management programs giving priority to non-structural measures. In the planning area, the Soil Conservation Service, Corps of Engineers, Civil Defense, other sponsoring and participating agencies, should reevaluate the possibility of federal participation in implementing a combination of strong flood plain zoning, wetlands protection, floodproofing, relocation, and flood warning with selected structural measures.**

In conjunction with this recommendation,

2. **Apply structural solutions selectively. The Soil Conservation Service, Corps of Engineers, and other sponsoring and participating agencies should consider implementing a combination of debris removal, dam removal or coordinated operation, and bridge opening adjustments, together with strong non-structural measures as viable alternatives to major structural construction.**

Maintenance of existing structures is also part of an overall flood plain management program. Growing interest and support of rehabilitating mill dams is being expressed by

municipal officials and citizen groups *(see Chapter 6)*. Dam maintenance together with coordinated operation would help to keep the flood retention capacity of mill ponds intact, as well as offer important recreation opportunities. Debris and silt removal on a regular basis will also help to maintain the design effectiveness of existing structures.

More specifically, and as a condition for future federal financial assistance:

3. **Adopt local flood plain zoning preventing adverse flood plain development. Municipalities should adopt flood plain zoning to prevent adverse development in flood prone areas (and particularly in the 100-year floodway) as defined under the National Flood Insurance Program.**

Communities can strengthen local flood plain regulations by incorporating soils information, inland and coastal wetlands, eroding areas, and storms of record on the map upon which the zoning is based. All related regulations – building codes, subdivision regulations, sanitary codes – should reinforce this policy of preventing adverse development and redevelopment in the 100-year flood plain. The regulations should also take advantage of the restrictive provisions of state wetlands regulations, scenic rivers programs, and the like.

Related to local *zoning* are two recommendations for controlling local sedimentation and inland erosion problems.

4. **Establish local sediment and erosion control ordinances. Municipalities, assisted by the U.S. Department of Agriculture and the Executive Office of Environmental Affairs in Massachusetts and the Department of Natural Resources in Rhode Island, should establish local sediment and erosion control ordinances.**

A model for such ordinances is included in the more detailed information prepared for the Study and available at NERBC.

5. **Establish forest buffer zones. Municipalities should establish appropriate forest buffer zones within 200 feet of streams and lakes to preserve vegetation and maintain natural systems through forestry techniques to help keep non-point source pollutants from reaching sensitive water quality areas.**

Towns with existing high and medium-high development pressure *(see Chapter 3, Guiding Growth)*, particularly in Rhode Island (Cumberland, Smithfield, and North Smithfield), should be among the first to implement these two recommendations. In addition, for forested areas,

6. **Establish a forestry program. Landowners should control forest road erosion by proper road location and stabilization activities such as seeding and ditching.**

In conjunction with these four local actions,

7. **Establish local regulations to strengthen flood plain management. Municipalities should ensure that all local regulations, including building and sanitary codes, reinforce the intent of the zoning ordinances recommended above.**

Together with a zoning program,

8. **Acquire key flood plains and wetlands. Municipalities and state agencies should investigate continuing possibilities to acquire those wetlands and flood plain areas most significant for flood damage reduction and protection, and which have water supply, wildlife and/or recreation values.**

Particular emphasis should be given to protection of areas classified as unique natural areas and those located in areas subject to high and medium-high development pressure. More specific actions regarding wetlands protection are included in *Chapter 8 of the Regional Report.* Protection of wetlands and flood plains is also expected to help existing structural flood protection projects do their job by keeping flood flows to within the design capacity of the existing dams, channels, etc.

In built-up and heavily used areas, alternative locations outside the flood plain may not be feasible. Therefore:

9. **Locate in existing safe buildings in the flood plain. Where location outside the flood plain is not feasible, municipalities should encourage private interests to locate in existing safe buildings in the flood plain, and regulate new construction in the flood plain.**

Floodproofing, especially of existing buildings, is particularly appropriate where only moderate flooding is expected, where other types of flood protection are not feasible, or where activities on waterfront location need some degree of protection. Improved and expanded storm and flood forecasting and warning services, recommended in *Chapter 8 of the Regional Report*, will also be important in keeping

down future damage costs.

Implications

This approach is a good deal more restrictive than the National Flood Insurance Program requires. But it does make full recognition of resource limitations and natural functions of wetlands and flood plain areas. The SENE Study has found that all new development can be accommodated on C, F, and G lands *as discussed in the chapter on Guiding Growth,* so that protecting A and B Critical Environmental Areas, which include wetlands and flood plains, from inappropriate use need not be incompatible with a growing economy. In fact, a policy of resource protection and non-structural solutions is regarded as a significant step toward protecting the physical beauty of the region's landscape, which is expected to be in the long-term interest of the SENE region, while at the same time reducing overall public investment in after-the-fact protection measures.

CHAPTER 9 LOCATING KEY FACILITIES

One of the most difficult subjects to grapple with at the local level is the siting and operation of such key facilities as power plants, sand and gravel pits, petroleum refining, distribution and storage sites, and solid waste disposal. Bluntly stated, they are unwelcome neighbors. At the same time, however, few people are willing to live with the consequences of not having enough of the vital products or services provided by these operations. The situation is further complicated by increasing competition from other potential users of the sites which can be considered for key facilities.

Neither power nor petroleum facilities appear to be critical issues, either now or in the immediate future, in most of this planning area. However, issues involving the Port of Providence, technically within this planning area, are covered in *Chapters 7 and 9 of the Narragansett Bay Planning Area Report.* Solid waste management and recovery programs are underway in both states and should receive widespread community support. However, because the three basins in this planning area are major suppliers of construction aggregate to the region, the regulation of sand and gravel extraction operations is of special concern.

SAND AND GRAVEL EXTRACTION

Processing plants in the planning area produced 3.25 million tons of sand and gravel in 1970, valued at $4.4 million. Plants were located at Auburn, Grafton, Millbury (2), Sutton (2), Uxbridge, Attleboro, and North Attleborough, Massachusetts; Cumberland (2), North Smithfield (3), Johnston, Smithfield (2), and Pawtucket, Rhode Island. Most producers obtained material from sites within a few miles of the plant, and Blackstone basin operators indicated that they have undeveloped reserves of sand and gravel at additional sites.

In addition, quantities of crushed stone are produced at Wrentham, Massachusetts and Lincoln, Rhode Island. Shale is mined in Plainville, Massachusetts for use in manufacture of lightweight aggregate. However, while total reserves of sand and gravel for the Rhode Island section of the planning area are known (19 million cubic yards or 28.5 million short tons), figures do not exist for the Massachusetts portion of the planning area. Nevertheless, with proper management, the planning area should be able to continue to produce at current levels through 1990.

However, the Study has identified many of this planning area's communities as being under considerable development pressure, and this fact, combined with an increasingly restrictive attitude toward extraction, could significantly reduce the number of developable sand and gravel deposits in the mid-term future.

Zoning ordinances and bylaws control "earth removal" to some extent in all area towns except Worcester, Massachusetts. Mining is permitted by "special exception" in specific sections of Pawtucket, Woonsocket, and North Smithfield, Rhode Island. Otherwise, procedures exist in most towns specifying operating and post operating requirements. The most common procedures include permit application and fees, time limits on permits, and almost universally nominal permit violation fines. The town of Millville, Massachusetts requires a $1,000 performance bond, and Plainville, Massachusetts requires annual progress reports with detailed topographic maps from mineral extraction operators.

While operating under these rather variable restrictions is doubtless quite easy, getting permits, according to operators, is another thing altogether. Towns are frankly reluctant to permit mining operation for fairly obvious reasons. Traditionally, sand and gravel pits have been ugly, dirty, noisy operations causing significant traffic congestion and hazard, and often decreasing land values in adjacent areas.

At the same time, however, construction aggregate is vital to our way of life, and for the foreseeable future, at least, alternative sources and technologies appear impractical and highly uneconomical. Importation of construction material from out-of-basin sources is prohibitively expensive and serves only to dump the problem into someone else's lap. Alternative building materials do not yet exist, and the economic feasibility of offshore mining has not yet been established.

Recognizing that the planning area, already the prime producer in the region, will likely continue to produce construction aggregate, the Study urges that the recommendations outlined in *Chapter 9 of the Regional Report* be implemented by both states in this area. Such a program would provide for state-established operating standards under a local land use approval system, provide a standard permitting procedure for all extraction activities and guarantee site reclamation, and call for a minerals survey for the Massachusetts portion of the area.

Representatives of Contributing State And Federal Agencies

FEDERAL—STATE

New England River Basins Commission
R. Frank Gregg, Chairman**; Robert D. Brown, Staff Director** **Southeastern New England Study Staff:** Robert Kasvinsky, Study Manager*; Jane F. Carlson; Cornelia V. H. Ferber; Alan Jacobs; Ernesta Kracke; James Luty; William Mahoney; Priscilla Newbury; William E. Nothdurft; William E. Richardson; Philip Tabas.

New England Regional Commission
Thomas Fitzpatrick**; Tirath Gupta* (consultant); Robert Bogen*.

MASSACHUSETTS

Executive Office of Environmental Affairs
Dr. Evelyn Murphy, Secretary**

Coastal Zone Management Program
Matthew Connolly**; Dan Calano*.

Department of Environmental Management (formerly Department of Natural Resources)
Arthur W. Brownell, Commissioner** (to February 1975); Dr. Bette Woody, Commissioner** (as of June 1975).
Division of Water Resources: Charles Kennedy**; Emerson Chandler* (as of June 1974); Clinton Watson* (to June 1974).
Water Resources Commission: Robert E. Lautzenheiser.

Department of Community Affairs
Lewis S. W. Crampton, Commissioner** (to February 1975); David Terry*.

Resources Management Policy Council
Vincent Ciampa.

Department of Environmental Quality Engineering
Division of Environmental Health (formerly Department of Public Health): George Coogan.

Division of Water Pollution Control: Tom MacMahon**; Dick Young*; Al Cooperman*.

RHODE ISLAND

Rhode Island Statewide Planning Program
Daniel W. Varin, Chief**; Patrick V. Fingliss*; Lou David.

Coastal Zone Management Program
Coastal Resources Management Council: John Lyons, Chairman.
Coastal Resources Center: Stuart O. Hale; Malcolm Grant.
Water Resources Board: Robert Russ**; Peter Calese*.

CONNECTICUT

Department of Environmental Protection
Joseph Gill, Commissioner**; Robert B. Taylor, Director* of Water Compliance.

FEDERAL

Department of Agriculture
Soil Conservation Service: Dr. Benjamin Isgur**; Philip H. Christensen**; Stephen Claughton*.
Economic Research Service: John Green*.
Forest Service: Kenneth Johnson**; Sam Becker* (to December 1973); Neil Lamson* (to March 1974); Douglas Monteith* (as of March 1974).

Department of Commerce
National Weather Service: Norman L. Canfield** (to September 1975); Albert Kachic**; Joseph J. Brumbak.
National Marine Fisheries Services: Russell T. Norriss**; Christopher Mantzaris*.
Bureau of Economic Analysis: Henry DeGraff; Gene Janisch.
Maritime Administration: William S. Chambers**; Robert L. Safarik.

Department of Defense, Department of the Army, Corps of Engineers
Planning Division: Joseph Ignazio, Chief** (to June 1974).
Policy and Long Range Planning Branch: Lawrence Bergen, Chief**; (As of June 1974); John Landall*; Gardner Blodgett*; Paul Pronovost.
Plan Formulation Branch: Steven Onysko
Coastal Development Branch: Harvey Minsky

Department of Housing and Urban Development
David Prescott** (to September 1974); Sheldon Gilbert** (as of September 1974); JGA/Wallace, Floyd, Ellenzweig* (consultants).

Department of Transportation
Federal Highway Administration: Stanley R. Davis**; Charles L. O'Donnell** (to October 1975).
U.S. Coast Guard: Capt. Bernard Thompson* (to October 1973); Capt. Alvin P. Durgin, Jr.* (October 1973 to August 1974); Cdr. C. R. Lindquist* (to February 1974); Capt. Royal E. Grover, Jr.* (as of August 1974); Rear Admiral James P. Stewart** (as of October 1975).

Environmental Protection Agency
Water Quality Branch; Walter Newman, Chief**; Roger Duwart*; Clyde Shufelt*.

Water Supply Branch: Jerome Healey*; Stephen Lathrop*; Alma Rojas* (to February 1974).

Department of the Interior
Roger Sumner Babb** (as of December 1974); Mark Abelson** (to June 1973); Kenneth Young** (to May 1974); William Patterson** (as of September 1974); Robert B. Ryder* (as of May 1975).
Bureau of Mines: Robert D. Thompson*; Joseph Krickich* (to March 1974); Peter Morey* (as of March 1974).
Bureau of Outdoor Recreation: James Donoghue* (to March 1973); Eric Finstick* (to September 1974); Alan Hutchings* (as of September 1974); Earl Nichols (as of September 1974).
Fish and Wildlife Service: Melvin Evans**; Roy Landstrom*; Dewey Castor; Dave Ferguson; Fred Benson; Tom Oliver.
National Park Service: David Clark**; David Kimball; Richard Giamberdine.
University of Massachusetts (consultants for NPS): Ervin Zube; Julius Gy Fabos; R. Jeffrey Riotte*.
U.S. Geological Survey: Michael Frimpter*.

Federal Power Commission
Martin Inwald*; Jonas Barish*.

** Policy level Coordinating Group
* Technical level Study Management Team

REGIONAL PLANNING AGENCIES

Merrimack Valley Regional Planning Commission
Margaret Concannon; Stephen Aradas

Metropolitan Area Planning Council (also HUD, SENE Study Consultants)
James Miller; Lawrence Brennan; Bob Joseph (to May 1974).

Old Colony Planning Council
Daniel Crane; Robert McMahon.

Cape Cod Planning and Economic Development Commission
Robert Robes; Paul Doane.

Dukes County Planning and Economic Development Commission
Robert Komives.

Nantucket Planning and Economic Development Commission
William R. Klein.

Central Massachusetts Regional Planning Commission
David H. Kellogg; James Arnold.

Southeastern Regional Planning and Economic Development District
William Toole; Eric Savolainen; Steven Smith; Alexander Zaleski.

Southeastern Connecticut Regional Planning Agency
Richard B. Erickson

CONSULTANTS (not otherwise shown)

Urban Waters Special Study
Skidmore, Owings & Merrill

Economic Analysis
Nathaniel Clapp, Barry C. Field; John M. Gates; Thomas Grigalunas; J. G. Sutinen; Gregory A. Vaut.

Legal and Institutional Analysis
Thomas Arnold; Morton Gorden, Development Sciences, Inc.; Frances X. Cameron, Interface; Edward R. Kaynor; Edward Selig.

Planning Analysis
William V. McGuinness, Jr.; Robert Gidez and Paul Merkens, Intasa; Harry Schwartz.

Public Participation
Survey Research Program; Stephen Logowitz.

CITIZEN ADVISORY COMMITTEE AND REGIONAL SCIENTIFIC TASK FORCE

Gordon Abbott, Milton, Ma.; Dr. Daniel Aldrich III, North Dartmouth, Ma.; Nancy Anderson, Reading, Ma.; Arthur Barnes; West Newton, Ma.; Gerald Beals, Easton, Ma.; Leo Bouchard, Smithfield, R.I.; Prof. Derek Bradford, Providence, R.I.; Jack Conway, Hanover, Ma.; John Davis, Pawcatuck, Conn.; Peter Donovan*, Brighton, Ma.; Charles E. Downe, West Newton, Ma.; Dr. Madge Ertel, Amherst, Ma.; Dennis Ducsik, Cambridge, Ma.; Michael Everett*, Providence, R.I.; Dr. John W. Farrington, Woods Hole, Ma.; Barbara Fegan, Chairman, South Wellfleet, Ma.; Michael Frucci, Hyannis, Ma.; Dr. Frederick Glantz, Boston, Ma.; William Graves, Raynham, Ma.; Rolf Hardy, Boston, Ma.; Robert A. Harpell, Cumberland, R.I.; Alfred Hawkes, Providence, R.I.; Paul Hicks, Providence, R.I.; Dorothy Hunnewell, Wellesley, Ma.; Nancy Hustvedt, Woburn, Ma.; John Kellam, Providence, R.I.;Walter Kelly, Waltham, Ma.; Dr. Bostwick Ketchum*, Woods Hole, Ma.; Paul Klotz, Westerly, R.I.; Ken Lagerquist, Seekonk, Ma.; Maurice Leduc, Coventry, R.I.; Frank Lee, Boston, Ma.; Elwood Leonard, Ashton, R.I.; Glenn McNary, North Falmouth, Ma.; Dr. Sanford Moss, Westport, Ma.; Herbert Nickerson, Gloucester, Ma.; Ed Plumley, Westboro, Ma.; Spencer Potter, Jamestown, R.I.; Ted Prall, Boston, Ma.; Martha Reardon, Quincy, Ma.; James Rogers, Lexington, Ma.; Dr. Neils Rorholm*, Kingston, R.I.; Neil Ross, Kingston, R.I.; John T. Scanlon, East Greenwich, R.I.; Dr. William Seifert*, Cambridge, Ma.; Roland Sherman (to May 1975), Worcester, Ma.; Barbara Sjoberg, Pawtucket, R.I.; Frederick Smith*, Cambridge, Ma.; Reed Stewart, Marshfield Hills, Ma.; Merlin Szosz, Foster, R.I.; Dr. Clarence Tarzwell*, Wakefield, R.I.; Marshall Taylor, West Somerville, Ma.; Jens Thornton, Quincy, Ma.; Bruce Tripp, Woods Hole, Ma.; Ivan Valiela, Woods Hole, Ma.; Thomas Weaver, Kingston, R.I.

*RSTF Member